Development of a photographic food atlas to support food portion estimation among children and adolescents aged 9-14 years in Nairobi, Kenya

Hanna Mari Walsh
The Department of Food and Nutrition
Faculty of Agriculture and Forestry
University of Helsinki
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HELSINGIN YLIOPISTO
HELSINGFORS UNIVERSITET
UNIVERSITY OF HELSINKI

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Abstract

Introduction

Kenya has recently acquired lower-middle income country status and is facing the triple burden of malnutrition. There is a shortage of data on food intake habits of children and adolescents especially in the rapidly changing urban environments. To be able to reliably measure food intake, one must be able to accurately estimate food portion sizes. Children's ability to recall portion sizes consumed can vary widely. When a photographic food atlas designed for children with applicable portions is used, it can improve children's estimation of food portions.

Objectives

The aim of this study was to develop a photographic food atlas to be used in assessing portion sizes among Kenyan adolescents aged 9-14 years living in urban areas, to support a quantitative 7-day food frequency questionnaire. The second aim was to assess the usability of the atlas amongst 9-14-year-olds and professionals working in the field of nutrition.

Methodology

A steering group of Finnish and Kenyan nutritionists was formed to oversee the development of the atlas. Literature and other official documents were reviewed to identify the most commonly consumed foods among 9-14-year-old Kenyans. To obtain weighed portion size data, participants were recruited in Nairobi sub-counties Embakasi Central and Langata to represent low- and middle-socioeconomic status respectively. Twenty-one participants aged 9-14 years participated in the weighing of portion sizes, food portions from street markets were also weighed. Three portion sizes (A, B, C) were calculated for most of the 88 food items in the photographic food atlas. Portion B was the average of all weighed portion sizes, portion A was half of B, and portion C was one and half times B. Cooking demonstrations were arranged with the families of participants and the food portions were weighed out and photographed. A photographic food atlas was compiled, and its usability was tested amongst eight adolescents and four nutrition professionals. The usability survey consisted of Likert scale and open-end questions to ascertain acceptability of the atlas. Verbal feedback and observations were also recorded.

Results

Based on the usability survey, the photographic food atlas received the Usability Score of "OK" and "Good" from adolescents and nutrition professionals respectively. All eight adolescents agreed that the atlas helped them recall portion sizes, but half disagreed and one was unsure whether they could use the atlas on their own. All four professionals agreed they would use the atlas in their work, but all found the quality of photographs poor. Two adolescents disagreed when asked if the portion sizes were small enough and one disagreed when asked if the portion sizes were large enough. However, all professionals agreed that portion sizes were reasonable for the age group. Professionals gave verbal suggestions on improvements, for example, which foods were missing, how to adjust layout as well as the shapes of portion sizes.

Conclusion

An atlas consisting of 88 most commonly consumed Kenyan foods was developed based on weighed portion sizes of 9-14-year-old Kenyans. The shapes of portion sizes as well as range of portion sizes were crucial for its usability. Poor picture quality hampered recognition of pictures. Clear instructions and explanation of the purpose of the atlas were crucial. A second version of the atlas was developed based on the feedback. The updated atlas, including 173 food items, was used in a cross-sectional study in Nairobi. Further research is recommended to validate the photographic food atlas in order to identify the possible bias it may introduce to portion size estimation.

Keywords Portion size, food atlas, food photographs, children, youth, nutrition, dietary intake, LMIC, Sub-Saharan Africa

Supervisors Maijaliisa Erkkola (University of Helsinki) & Sophie Ochola (Kenyatta University)

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Tiivistelmä

Johdanto

Alhaisen ja keskituloluokan maissa, kuten Keniassa, lasten ja nuorten ravitsemuksesta tiedetään hyvin vähän. Kun maa on siirtymässä alhaisen tuloluokan maasta keskituloluokan maaksi, virheravitsemuksen riski moninkertaistuu. Tällöin väestössä ja samassa kotitaloudessa voi esiintyä samanaikaisesti sekä ali- että yliravitsemusta ja ravinnonpuutteita. Tästä johtuen on tärkeää saada lisää tietoa lasten ja nuorten ravitsemuksesta ja ruoankäytöstä sekä niissä tapahtuvista muutoksista. Jotta lasten ja nuorten ruoankulutusta voidaan mitata tarkasti ja luotettavasti, heidän täytyy osata luotettavasti arvioida ruoka-annostensa koko. Annoskoon arviointi tarkentuu lasten käyttäessä annoskuvakirjaa, jossa on ikäryhmälle sopivia annoskuvia.

Tavoitteet

Tämän tutkimuksen tavoitteena oli kehittää annoskuvakirja tukemaan 9–14-vuotiaiden nairobilaisten lasten annoskokojen arviointia ruoankäyttöfrekvenssikyselyn yhteydessä. Toinen tavoite oli selvittää 9–14-vuotiaiden lasten sekä kenialaisten ravitsemustieteilijöiden näkemystä kehitetyn annoskuvakirjan hyväksyttävyydestä ja käytettävyydestä.

Menetelmät

Julkaisuista ja muista virallisista dokumenteista selvitettiin taustatietoa yleisimmistä kenialaisista ruokalajeista ja annosko'oista. Annoskokojen määritystä varten rekrytoitiin 21 9–14-vuotiasta lasta, joista kymmenen Nairobin Embakasi Central-alueelta ja yksitoista Nairobin Langata-alueelta. Vierailujen yhteydessä heidän annoskokonsa punnittiin ja selvitettiin yleisimmin syödyt ruokalajit. Lisäksi selvitettiin alueiden katukauppojen, ravintoloiden sekä valintamyymälöiden tarjonta ja tarjolla olevien annosten koot punnittiin. Punnittujen annoskokojen perusteella määriteltiin kolme annoskokoa (A, B, C) suurimalle osalle ruokalajeista. B-annoskoko oli punnittujen annoskokojen keskiarvo, A oli puolet B:sta ja C puolitoista kertaa B. Kyselyyn osallistuneiden lasten äideille järjestettiin ruoanvalmistustilaisuus, jossa he valmistivat annoskuvakirjaan tulevat ruoat ja annoskoot punnittiin ja kuvattiin. Lopuksi annoskuvakirja koottiin ja sen käytettävyyttä testattiin kahdeksan lapsen ja neljän ravitsemustieteilijän keskuudessa. Käytettävyyskysely sisälsi yhdeksän Likert-asteikollista väitettä sekä avoimia kysymyksiä. Tutkittavien suullinen palaute ja tutkijoiden huomiot kirjattiin ylös.

Tulokset

Annoskuvakirja sai käytettävyysarvioiksi lapsilta "OK" ja ravitsemusosaajilta "Hyvä". Kaikki kahdeksan nuorta uskoivat annoskuvakirjan auttavan heitä annoskokojen mieleen palauttamisessa, mutta vain puolet uskoi, että osaisivat käyttää annoskuvakirjaa yksin. Kaikki neljä ravitsemusosaajaa kertoivat, että käyttäisivät annoskuvakirjaa työssään, mutta kaikki kommentoivat, että valokuvien laatu oli kehno. Kolme lapsista katsoi, ettei annoskuvakirjan annoskoot vastaa heidän tavallisia annoskokojaan, mutta kaikki ravitsemusosaajat uskoivat, että annoskoot olivat sopivia ikäryhmälle. Ravitsemusosaajat antoivat suullista palautetta liittyen siihen, mitkä ruokalajit puuttuivat, missä järjestyksessä ne tulisi esittää sekä esittivät korjauksia ruoka-annosten muotoon.

Johtopäätökset

Valmis kirja sisälsi 88 ruokalajia. Annoskuvakirjan käytettävyyteen vaikutti etenkin valokuvien laatu sekä ruoka-annosten muodot. Selvät käyttöohjeet olivat myös tarpeelliset. Tässä tutkimuksessa saadun palautteen perusteella tehtiin annoskuvakirjasta toinen versio, jota käytettiin myöhemmin 160 lapsen poikkileikkaustutkimuksessa Nairobissa. Jatkotoimenpiteenä annoskuvakirja tulisi validoida, jotta tutkimuksissa voidaan paremmin huomioida sen tuomia virhelähteitä annoskokojen arviointiin.

Avainsanat Annoskoko, annoskuvakirja, annoskuva, lapset, nuoret, ravitsemus, Kenia

Ohjaajat Maijaliisa Erkkola (Helsingin yliopisto) & Sophie Ochola (Kenyatta University)

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Muhtasari wa Kiswahili

Utangulizi

Hali ya lishe ya watoto na vijana ni ya riba maalum kwa nchi ambazo ziko katikati ya mabadiliko ya kiuchumi. Kenya hivi karibuni imefikia hadhi ya nchi ya kipato cha kati na inakabiliwa na mzigo aina tatu ya utapiamlo. Uhaba wa taarifa ipo juu ya tabia ya ulaji wa chakula kwa watoto na vijana hasa katika mazingira yanayobadilika haraka haswa makazi mijini. Ili kuweza kupima ulaji wa chakula kwa uhakika, mtu lazima awe na uwezo wa kukadiria kwa usahihi ukubwa wa sehemu ya chakula. Uwezo wa watoto kukumbuka ukubwa wa sehemu waliyoila inaweza kutofautiana sana. Wakati picha ya chakula iliyotengezwa kwa minajili ya watoto ikiwa na ukubwa wa sehemu ya chakula sahihi itatumika, inaweza kuboresha makadirio ya sehemu za chakula kwa watoto.

Malengo

Kusudi la utafiti hii lilikuwa kutengeneza atlasi ya picha za chakula zitakazotumika katika kutathmini ukubwa wa sehemu ya chakula kati ya vijana wa Kenya wenye umri wa miaka 9 hadi 14 wanaoishi maeneo ya mijini ili kusaidia kukusanya taarifa ya kujaza dodoso la marudio ya chakula ya siku saba (7 day FFQ). Kusudi la pili lilikuwa kutathmini utumiaji wa atlasi hii kati ya watoto wa miaka 9 hadi 14 na wataalamu wanaofanya kazi kwenye nyanja ya lishe.

Mbinu

Kamati ya utendaji ya wafini na wakenya ya wataalamu wa lishe kiliundwa kusimamia utengenezaji wa atlasi ya picha ya chakula. Nyaraka na hati zingine rasmi zilikaguliwa ili kubaini vyakula vya kawaida zinazotumiwa kati ya wakenya wenye umri kati ya miaka tisa hadi kumi na nne (9-14). Ili kupata taarifa ya kipimo cha ukubwa wa sehemu ya chakula, washiriki waliandikishwa kutoka kaunti ndogo za Nairobi ikiwemo Embakasi ya Kati na Langata, ilikuwakilisha sehemu yenye hali ya juu ya kiuchumi na kijamii na hali ya chini ya kiuchumi na kijamii kwa mtawalia. Washiriki ishirini na moja (21) wenye umri kati ya miaka tisa na kumi na nne (9-14) walishiriki katika utathmini wa ukubwa wa sehemu ya chakula. Aina tatu za ukubwa wa sehemu (A, B, C) zilihesabiwa kwa zaidi ya orodha themanini na nane (88) ya chakula katika atlasi ya picha za chakula. Sehemu ya B ilikuwa wastani wa ukubwa wote wa sehemu zilizo na uzito, A ilikuwa nusu ya B, na C ilikuwa mara moja unusu ya B. Maandalizi ya kupika ilipangwa na familia za washiriki na wastani wa ukubwa wa chakula zilipigwa picha. Atlasi ya picha za chakula ilikusanywa na utumiaji wake ulijaribiwa kati ya vijana wanane na wataalamu wanne wa lishe. Utafiti wa utumiaji wa atlasi hii ya picha ya chakula ulijumuisha kutumia dodoso ya “Likert Scale” na maswali ya wazi ili kuhakikisha kukubalika kwa atlasi ya picha za chakula. Maoni na uchunguzi kutokana na utafiti pia zilirekodiwa.

Matokeo

Atlasi ya picha ya chakula ilipata alama ya utumizi ya "Sawa" na "Mzuri" kutoka kwa vijana na wataalamu wa lishe mtawaliwa. Vijana wote wanane wakikubaliana kwamba atlasi hii ya picha ya chakula iliwasaidia kukumbuka ukubwa wa sehemu ya chakula walio ila, lakini nusu hawakukubaliana na mmoja hakuwa na uhakika alipoulizwa ikiwa angeweza kuitumia atlasi hii mwenyewe. Wataalamu wote wanne walikubaliana kuwa wanageweza kutumia atlasi hii ya picha ya chakula kwenye kazi zao, lakini wote walipata ubora wa picha kuwa duni. Vijana wawili hawakukubaliana iwapo ustani wa sehemu za ukubwa wa chakula ulikuwa ni ndogo kiasi cha haja na mmoja hakukubaliana na ikiwa ustani wa sehemu ya chakula ilikuwa kubwa kiasi cha kutosha alipoulizwa. Walakini, wataalamu wote walikubaliana kuwa ukubwa wa sehemu ya chakula zilikuwa sawa kwa kikundi cha vijana wenye umri 9-14. Wataalam walitoa maoni yao jinsi uboreshaji unawezatekelezwa, kwa mfano, vyakula vilivyokosekana kwa orodha ya vyakula na jinsi utaratibu wa mpangilio wa vyakula inastahili kuwa kama vile maumbo ya saizi ya sehemu za chakula.

Hitima

Atlasi linayojumuisha vyakula themanini na nane (88) vya kawaida vinavyotumika kwa sana nchini Kenya lilitengenezwa kwa kuzingatia uzani wa ukubwa wa sehemu za chakula kutokana na vijana wenye umri wa miaka tisa hadi kumi na nne wakutoka Kenya. Atlasi hii lilitengenezwa kutokana kwa nadhira katika fasihi na kwa kutumia fasihi nyingi na vyanzo vya walivyohojiwa. Maumbo ya ukubwa wa sehemu ya chakula pamoja na idadi ya ukubwa wa sehemu ya chakula yalikuwa muhimu kwa utumiaji wake. Ubora wa picha ambao ulikuwa duni pia ulizuia utambuzi wa picha hizi. Toleo la pili la atlasi lilitengenezwa kutokana na maoni zilizokusanywa. Atlasi hiyo pamoja na orodha ya chakula mia moja sabini na tatu (173), lilitumiwa kwenye utafiti jijini Nairobi. Utafiti zaidi unapendekezwa ilikudhibitisha atlasi ya picha ya chakula ili kubaini uwezekano unaotokana na upendeleo ambao unaweza kuingizwa katika makadirio ya ukubwa wa sehemu ya chakula kwenye atlasi.

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Hanna Walsh
Helsinki, March 2020

Table of Content

Acronyms and abbreviations

BMI	Body mass index
CHV	Community health volunteer
FAO	Food and Agriculture Organisation of the United Nations
FFQ	Food frequency questionnaire
FGD	Focus group discussion
GDP	Gross domestic product
IPSAS	Interactive portion size assessment software
ISO	Sensitivity of the image sensor of a camera
KDHS	Kenya Demographic and Health Survey
KENFIN-EDURA	Kenya Finland Education and Research Alliance
LMICs	Low and middle income countries as defined by DAC of OECD
NCD	Non-communicable disease
OECD	Organization for Economic Cooperation and Development
OHCHR	Office of the United Nations High Commissioner for Human Rights
SES	Socioeconomic status
SUS	System Usability Scale
UNICEF	United Nations Children's Fund
WHO	World Health Organisation

Dictionary of Kenyan foods

bhajia	Gram flour and spice coated deep-fried potato slices.
biriyani	A spicy rice dish that is originally from India. Can include chicken, fish, mutton, prawns or beef.
chapati	A circular pan-fried flat bread often made from wheat flour, but other flours can also be used.
githeri	A traditional Kenyan dish made of maize and beans. Can also include other legumes and vegetables.
Irish potato	The name used in Kenya for "white" potatoes (*Solanum tuberosum*) to differentiate it from the sweet potato also grown in Kenya.
KDF	A type of square-shaped larger *mandazi*. Named after the Kenya Defence Forces.
kachumbari	A fresh tomato, onion and coriander salad with lime and spices. Can also include cucumber or avocado.
managu, kunde, terere, saga/saget	Also generally known as "traditional vegetables" in Kenya; in English they are African nightshade, cow pea leaves, amaranth leaves and spider plant leaves.
mandazi	A type of deep-fried doughnut, often made from wheat flour.
matoke	A green banana/plantain stew.
matumbo	Offal, often intestine.
mukimo	A traditional Kenyan dish made of mashed (Irish) potato and green vegetables. In some areas, it can also include maize, beans, sweetcorn or sweet potato.
nyama choma	Meaning grilled meat in the Kiswahili language, usually goat or beef.
omena	Silver cyprinid – a small fish belonging to the carp family also known as the Lake of Victoria sardine.
pilau	A rice dish traditionally found by the coast, possibly of Indian influence, rich in spices such as cumin, curry, cardamom, anise and cinnamon.
samosa	Triangular shaped pastry, of Indian origin, filled with vegetables or meat and deep fried.
Sukuma Wiki	Braised collard greens (kales and spinach), often with tomato and onion.
ugali	Kenya's staple food, a stiff maize flour porridge. Can also be made of millet or sorghum flour and is also known as *pap* or *nsima.*
uji	A fermented porridge, known simply as "porridge", often made of millet flour, though it can also be made of maize or sorghum flour.

1 Introduction

Kenya acquired lower-middle income country status according to the Organisation for Economic Co-operation and Development's (OECD) ranking, and the economic progress has started to have an effect on health and lifestyle (1,2). Kenya faces the triple burden of malnutrition where over- and undernutrition as well as micronutrient deficiencies coexist in the same country, town and even household (3,4). There has been a rapid rise of non-communicable diseases (NCDs) in Kenya such as circulatory disease, hypertension and diabetes over the past decade (5).

Child and adolescent nutrition status are of specific interest in countries that are in the middle of economic change because they are often at higher nutritional risk compared to adults (6). During adolescence, both girls and boys grow at a faster rate than any other time, except infancy (6). The calorie requirements of boys are higher than at any other time in their life and likewise for girls, apart from pregnancy and lactation. There is a shortage of data on food intake habits of children and adolescents especially in the rapidly changing urban environments of Kenya (7). Within low and middle income countries (LMICs) there is a growing trend of a nutrition transition, characterised by a rapid increase in dietary intake of energy-dense foods and beverages, coupled with reduced physical activity and changing eating patterns among adolescents (8). However, more research is needed on children's and adolescents' nutrition status and their shifting dietary habits.

One of the most common ways of determining nutrition status is measuring food intake. To be able to reliably measure food intake, one must be able to accurately estimate food portion sizes, which can be challenging, as each method has bias and errors (9). Weighing food is considered the most accurate method of measuring food intake and portions, however weighing foods is burdensome and time-consuming for participants and may alter consumption behaviour, as well as reduce participation (10). Children's abilities to recall foods consumed and to use portion size estimation tools can vary widely due to age, cognitive abilities and type of food (11). When a photographic food atlas with applicable portion sizes for children is used, it can improve children's estimation of food portions (12). There is a lack of suitable, localised tools to measure food intake in LMICs (7). Hence, localised tools to aid children and adolescent portion size estimation are needed (9).

In the present study, the aim was to produce a photographic food atlas consisting of the most commonly consumed foods in low- and middle-socioeconomic areas of Nairobi, Kenya, with applicable portion sizes for 9-14-year-olds.

2 Literature review

2.1 Development of a photographic food atlas

2.1.1 What is a photographic food atlas?

Nelson & Haraldsdóttir (13) define a photographic food atlas as multiple photograph series, usually bound together in a single volume. A photographic series is a set of photographs depicting different portions (often 3-8 portion sizes) of a particular food. A portion is the amount of food that one chooses to eat at a sitting and may be smaller or larger than the standardised serving of the food. A portion can consist of multiple servings (amount of food served in a single helping) and does not include any leftovers.

Photographic food atlases are often country- and culture-specific and are used as a tool for portion size estimation in the field. Multiple countries have their own photographic food atlases depicting the standard portion sizes for adults of the most commonly consumed foods in their country. Photographic food atlases have been developed for many European countries such as Finland (14), UK (15), France (16) but also for a number of countries in Sub-Saharan Africa (17,18), North Africa and the Middle-East (19–21), Asia (22) and South America (23,24).

2.1.2 Theory of developing an atlas

Practical guidelines for developing and using a photographic atlas for assessing food portion sizes have been described by Nelson & Haraldsdóttir (13). They outline five steps to developing a photographic food atlas:

1. Form a steering group – include nutritionists, psychologists and sociologists.
2. Consult widely – the researchers and dietitians who will use the photographs should be consulted as well as the target population, as they are familiar with the food habits of the population and will be the ones using the photographic food atlas.
3. Use population-based data on types of food and ranges of portion sizes commonly consumed – information from existing surveys, carry out new surveys, use weighed portion size data where possible.
4. Select foods to be included.
5. Repeat step 2: consult widely – ensure that the final selection of food and portion size rang is in alignment with what is required.

When creating a photographic food atlas, the objective is to design an atlas that minimises the errors in estimates of portion size. According to Nelson & Haraldsdóttir (13) there are four things that will affect an individual's ability to evaluate portion size. These are the size of the image, the number of portion sizes, the range of portion sizes and the interval between portion sizes. Research has shown that, as well as these issues, there are other aspects of the photographic food atlas that may affect the accuracy of estimation, such as, the type of food (amorphous or not), order of presentation, labels used, the background of the picture and use of reference object, colour of the photograph and placing of foods as well as the users' characteristics. These will be discussed below.

2.1.3 Foods to include

Nelson & Haraldsdóttir (13) state there are two guiding questions to discuss when deciding which foods to include in the atlas and these are:

1. For which foods are photographs necessary?
2. How many foods are to be included?

According to Nelson & Haraldsdóttir (13) foods that are bought in standard and easily identifiable quantities that can be described (biscuits, yoghurts, chocolate bars) should not be included in a photographic food atlas, as they would only make producing the atlas more expensive and it would be more time-consuming for participants to use. Foods that should be included are foods with no set amounts but where the portion size varies along a continuum, or foods that are of irregular shape or size. They suggested that foods with certain characteristics are included, such as food served in mounds (mashed potato, peas, diced vegetables), slippery foods (pasta), food served in sauce or gravy (baked beans, stews), dry food served in bowls (cereals), wet food served in bowls (soups, stews), food served in wedges or blocks (pies and cakes) and discrete pieces of different sizes (meat chops, bread rolls, fruit, pieces of potato). It was also recommended that a variety of different types of foods are included with different properties and densities so that portion sizes of missing foods can be estimated with the help of a food with equivalent properties.

There is no one right answer to how many foods should be included and the best amount will vary from country to country and purpose of use. In some cases, food atlases have included hundreds of food items (24,25) whereas in other cases only a handful of photographs of staple food items were tested (26–30). In general, if a photographic food atlas is being compiled, it makes sense to try to include as many foods as possible. However, the more pictures there are and the thicker the atlas, the more burdensome it is to use for both examinee and examiner. This in turn may affect motivation and

accuracy of estimates. Nelson & Haraldsdóttir (13) stated that the rule of thumb is to have the fewest number of foods represented, which helps to achieve the desired level of precision.

Data on which foods to include should be collected from existing national surveys or dedicated surveys should be carried out to know which are the most important foods in the culture in question (13). It is important to make sure all the staple foods and commonly consumed foods are included and the foods that aren't so often consumed but are of nutritional significance. It is recommended to include and consult professionals who are familiar with the food habits of the population in the country and region. It is also recommended to consult the target population, as there may be foods which researchers regard as easy to estimate the weight of, but the target population could benefit from a visual aid for their estimations (13). If the photographic food atlas is being produced for a certain study, the research question and focus may also determine which foods are included.

2.1.4 Portion sizes

The number of portions, the range of portion sizes and the interval between portion sizes need to be considered. According to Nelson & Haraldsdóttir (13) the number of portions have varied from one to eight in studies conducted prior to their guidance. In more recent research, the number of portions has varied from three to nine (17,30). Three was a common number of portion sizes (17,18,25–27,31,32). Nelson & Haraldsdóttir (13) stated that it would be better to have an even number of photographs, as when there is an odd number, especially in the case of three portion sizes, participants will be tempted to pick the central image. Nelson et al. (33) reported that using only a few photographs results in some loss of precision. However, for example, Amougou et al. (17) used a photographic series of three portions and found that they could also generate a true picture of a person's energy and nutrient intake in Cameroon. Biltoft-Jensen et al. (34) used a photographic series of six portions and found that there were high overestimations of the macronutrient content of children's lunches. It may be tiring for participants to look through many portion sizes and try to distinguish differences, especially for children and adolescents whose attention span and ability to concentrate may not be as long as adults' (13). Yet Subar et al. found that accuracy of portion estimations increased when comparing the use of eight images to four (35).

Nelson & Haraldsdóttir (13) stated that the necessary range of portion sizes depended on the source of data available (national, *ad hoc*, or dedicated surveys) and the type of dietary assessment method the atlas will be used with (food frequency questionnaire, food checklist). Ideally the portion sizes should be based on weighed food records of the population and the age group in question (12,13,36). The important thing is to use a systematic approach and a wide range to include the smallest and

largest portion sizes consumed by the population. Nelson & Haraldsdóttir (13) suggested selecting the 5th to the 95th centile of reported serving sizes in a survey of adults. This was also used in food atlases with six or more portion sizes in the photographic series (12,28,29,34,37,38). Other percentile cut-offs such as 25th, 50th and 75th percentile were used to determine the size of three portions (26). When there are less portion sizes or limited data on portion size range, it may not be feasible to represent the whole range using centiles.

The interval between portion sizes in the images depends on how the range is divided by the number of portion sizes. The more portion sizes in a series there is or the smaller the range, the smaller the interval between portion sizes will be, whereas the less portion sizes there are or the larger the range, the larger the interval will be. A large interval will result in loss of information about actual amounts consumed, whereas a picture series with a very small interval may be burdensome and tiring for the participant to view and differentiate between the different portion sizes (13). Small intervals may result in estimation errors, especially at the larger end of portion sizes, as participants will have difficulties in differentiating between the portions (30,34,39). This is due to proportionate differences between smaller and larger portion sizes, for example, if there are three portion sizes: small 50g, medium 100g and large 150g. Though the increment is the same, the medium portion is two times bigger than the small, whereas the large portion is only one and a half times bigger than the medium. This can be overcome by using equal increments on a log scale as done by Foster et al. (28,40).

There are also different ways in which photographic series can be administered. The simple way is to ask participants to indicate which of the portion sizes presented is closest to their portion size. Another option is to also allow participants to indicate a portion size between two photographs and additionally whether smaller, or bigger than the smallest and largest portions. Using this method, if there were three portion sizes presented, there would then be four virtual portion sizes and seven portion size options to choose from in total. This has been associated with accurate estimations of portion sizes (17,20). Participants can also be allowed to state a fraction or multiple of a portion size. However, Nelson & Haraldsdóttir (13) did not recommend using only one photograph as it is challenging for subjects to estimate fractions or multiples of portion sizes. Also, Biltoft-Jensen et al. found that participants using fractions of one photograph or more, to estimate a portion of food, had significantly larger errors in their estimations (34).

2.1.5 Photography

There are many things to be considered when photographing the food portions, such as the background, lighting, distance, angle, settings of camera (shutter speed, zoom) and placing of foods.

It is important to keep the photographic conditions standard. When photographing food, the background should be kept neutral and unobtrusive (13). The same reference object such as a plate, knife, fork or other cutlery should be included in every picture to help participants scale the portions (13). In addition, Nelson & Haraldsdóttir (13) recommended providing subjects with the real plate or a life-size photograph, so they could also relate the portion sizes in the pictures to real life proportions. The majority of photographs in atlases have been taken against a white or neutral background and a white plate as well as a fork as reference objects. However, Bouchoucha et al. (20) used a blue background and Lombard et al. (26) used a black background for more contrast. Moreover, Korkalo et al. noted that the staple foods in Mozambique, rice and thick maize porridge, are light in colour, and hence using a plate of different colour might have resulted in better contrast between the food and plate (27).

Though not discussed by Nelson & Haraldsdóttir (13), in many studies, the photographic environment and settings were reported in minute detail and kept constant, for example by Brito et al. (32). The recommended and most commonly used angle for photography seems to be 45º, or a few degrees less for most foods (24,25,27,30,32,41). This is thought to be the best angle to give information on the surface area covered by the portion, but also allows perception of depth, which is important when evaluating the size of the portion (30). However, some studies differed in their choice of angle. Thoradeniya et al. (31) photographed portion sizes exclusively from directly above. Amougou et al. (17) used an angle of 55º whereas Biltoft-Jensen et al. (34) reported angles of 52° for casseroles, meat, vegetables, potatoes/rice, pasta and confectionary, 25° for fat spread and filling on bread and 35° for cake. Nissinen et al. (42) reported photographing fruits vertically.

Subar et al. studied the importance of the angle of the pictures by comparing results of portion size photographs taken from above with portion size photographs taken at an angle of 45º for 27 portion size images of foods. They found the only food where there was a significant difference between estimation errors at the two angles, was potato crisps, which were determined best by photographs obtained at 45° (35). Foster et al. (40) noted that the angle should represent the way the food is viewed before consumption and for young children, the angle of viewing the food may be smaller compared to that of adults, because of their smaller stature. However, this may only be true if children sit at an adult's table. In many schools and nurseries, tables and chairs are designed for children so the angle of viewing foods would be similar to that of an adult.

Settings of the camera include optical zoom, shutter speed and ISO as well as distance from the food. The aim is to achieve a clear, focused picture that is not overexposed, but is not dark either. The camera is often set upon a tripod to ensure stability and standard distance from the food. In addition

to adjusting the camera settings, lighting can be controlled in a studio set-up, which may be more challenging in the field.

2.1.6 Layout

The layout of atlas dictates the order of foods, the size of pictures and the colour of pictures and labels. The aim of formatting a photographic food atlas is to make it as easy to understand, read and use for the end-users (examinee and examiner) as possible. For this reason, pictures need to be presented in an easily viewable format, the atlas should not be too long, and foods should be in a logical order. The order of foods depends on how many foods are included and the country and culture in question (13). Often it is expedient to present foods in the order of food groups, or based on their properties/similar purpose of use, for example grain/cereal foods, starchy tubers, legumes, vegetables, fruits, dairy, animal products, fish, spreads, beverages and condiments.

Nelson & Haraldsdóttir (13) reported that image size can vary from A4 size (20x29 cm) photographs representing life-size portions, to smaller photographs (6x8cm). In more recent studies, the size of photographs ranged from 4.1 x 6.1cm (24) to life-size (18,26,27,31). Life-size images have been thought to produce the best results, but when forming a photographic food atlas of multiple foods it is not practical to present a series as life-size images due to difficulties in comparison and also the limited page number of a photographic food atlas (13). It is also burdensome for the participant to flip through many pages of a large atlas. Thoradeniya et al. (31) found that life-size photographs conferred no added advantage over small photographs, whereas Lombard et al. (26) found the opposite to be true. Korkalo et al. (27) also used life-size photographs and found that the proportion of participants who were able to give estimates within ±10 % of the actual portion size were somewhat modest, ranging from 20 % to 38 % for different foods. However, Venter et al. (18) were of the opinion that benefits of using life-size images outweighed the disadvantages of using them. Nevertheless, Nelson & Haraldsdóttir (13) recommended finding a photograph size that provides the largest amount of useful information in the least amount of space. To save space it has also been suggested that multiple portion sizes can be pictured on one plate. However, Nissinen et al. and Ovaskainen et al. found that multiple portion sizes on one plate were confusing (39,42).

According to Nelson & Haraldsdóttir (13) the most common order of presentation is from smallest to largest portion size in each photograph series. This was also the case in the more recent photographic food atlases, apart from in the case of Bernal-Orozco et al. (24), who presented portion sizes in reverse order, starting with the largest and ending with the smallest. Nelson & Haraldsdóttir (13) noted that arranging the photographs in ascending or descending order of size may lead to bias as the participants

may identify as “small” or “large” eaters and, therefore, pick a portion size at a certain end of the range even though it may not actually represent their portion size. This could be solved by placing photographs in a random order, but this is not recommended, as it would increase the burden for the respondent, especially in the case of a higher number of portion sizes.

According to Nelson et al. (33), seeing photographs in colour was associated with small but statistically significant overestimations of portion size. However, the participants said that looking at colour photographs was more interesting. Also, Turconi et al. (25) found that colour photographs may make the atlas more interesting to look at and thus help participants concentrate during longer interviews.

The different portion size pictures should also be labelled with numbers or letters so that they can be identified and connected to the accurate weight. However, Nelson & Haraldsdóttir (13) say that the labelling should be inconspicuous and should not distract from the photographs. Names and size labels such as “small”, “medium” and “large” should not appear on the photographs and even the weights of portions are recommended to be hidden.

2.2 Portion size estimation among children

There are many ways to aid the estimation of food portion sizes, for example, household measures, food models and pictures of food portions (43). There is a body of evidence that using photographic atlases and digital images to estimate the food portion sizes improves the accuracy of food portion estimations amongst adults in a variety of different countries and settings (17–20,22,23,25,26,35,39,44–47). In the following chapters the usability and validity of a photographic food atlas for portion size estimation among children and adolescents will be discussed.

2.2.1 Children and photographic food atlases

There is evidence that parents can accurately record a child’s dietary intake for meals consumed at home, however, they cannot know about meals consumed outside of the home (48). For this reason, it is of interest that children themselves report their food intake, especially as they transition into adolescence, which is characterised by more independence and activity outside the home (7).

A literature search was conducted on the online database, PubMed, (22.2.2019) to search for studies examining the use of photographic food atlases by children and adolescents. Three searches were conducted with the word combinations of *food atlas portion size, food picture portion size* and *food photographs potion size* and studies published from 2000 onwards were selected. Furthermore, the reference lists of articles were searched for further relevant articles. Fourteen articles were selected

for this literature review (12,17,24,25,27–32,34,37,38,41), two of which reported different aspects of the same study (28,37) (Table 1, Appendix 1).

Table 1. Summary of the validation studies of photographic food atlases. (See Appendix 1 for more details.)

Study	Study title	Participants and study setting
Amougou et al., 2016 (17)	Development and validation of two food portion photograph books to assess dietary intake among adults and children in Central Africa.	Children aged 8-13 years, Cameroon (n=224) - parents estimated portion sizes of 3-7-year-olds - children's results compared to adults'
Bernal-Orozco et al., 2012 (24)	Validation of a Mexican food photograph album as a tool to visually estimate food amounts in adolescents.	Adolescents aged 14-19 years, Mexico (n=463)
Biltoft-Jensen et al., 2018 (34)	Accuracy of food photographs for quantifying food servings in a lunch meal setting among Danish children and adults.	Children aged 8-12 years, Denmark (n=109) - children's results compared to adults'
Brito et al., 2012 (32)	Evaluation of photographs supporting an FFQ developed for adolescents.	Children and adolescents aged 11-18 years, Brazil (n=62)
Foster et al., 2006 (12)	Accuracy of estimates of food portion size using food photographs-the importance of using age-appropriate tools.	Children aged 4-11 years, UK (n=210) - children's results compared to adults'
Foster et al., 2008 (28)	Children's estimates of food portion size: the development and evaluation of three portion size assessment tools for use with children	Children and adolescents aged 4-16 years, UK (n=201)
Foster et al., 2008 (37)	Children's estimates of food portion size: the effect of timing of dietary interview on the accuracy of children's portion size estimates	Children aged 4-14 years, UK (n=108)
Foster et al., 2017 (38)	Development of food photographs for use with children aged 18 months to 16 years: Comparison against weighed food diaries - The Young Person's Food Atlas (UK).	Children and adolescents aged 1.5-16 years, UK (n=313) - parents estimated portion sizes of 1.5-4-year-olds
Frobisher & Maxwell, 2003 (29)	The estimation of food portion sizes: a comparison between using descriptions of portion sizes and a photographic food atlas by children and adults.	Children adolescents aged 6-16 years, UK (n=37) - children's results compared to adults'
Korkalo et al., 2013 (27)	Food photographs in portion size estimation among adolescent Mozambican girls.	Girls aged 13-18 years, Mozambique (n=99)
Lillegaard et al., 2005 (41)	Can children and adolescents use photographs of food to estimate portion sizes?	Children and adolescents aged 9-19 years, Norway (n=63)
Thoradeniya et al., 2012 (31)	Portion size estimation aids for Asian foods.	Children and adolescents aged 10-16 years, Sri Lanka (n=80)
Turconi et al., 2005 (25)	An evaluation of a colour food photography atlas as a tool for quantifying food portion size in epidemiological dietary surveys.	Participants aged 6-60 years, Italy (n=448) - all analyses carried out for the entire age group, but age was taken into account in analyses
Vereecken et al., 2010 (30)	How accurate are adolescents in portion-size estimation using the computer tool Young Adolescents' Nutrition Assessment on Computer (YANA-C)?	Adolescents aged 11-17 years, Belgium (n=128)

Very few studies solely reported the process of developing a photographic food atlas, but rather presented the development process together with the results on validity. Hence, these studies were selected on the basis that they discussed the development and validity of photographs, atlases, or

computer-based photographs/interactive systems as used by children or adolescents, of whom, at least a proportion were aged 9-14 years.

Based on the Office of the United Nations High Commissioner for Human Rights' (OHCHR) *Convention of the Rights of the Child*, a "child" is a person under the age of 18 years (49). The World Health Organisation (WHO) defines adolescents as those people between 10 and 19 years of age and thus the majority of adolescents can also be called children (50). Hence, when I use the word "children" in this study, I am referring to all ages under 18 years, including adolescents. However, in this literature review, I do use the terms children and adolescents intermittently, according to best fit, generally referring to participants over 10 years as adolescents and participants under 10 years as children.

The studies included in this literature review come from a wide range of countries and settings, include a wide range of ages and differ considerably in the study designs, as well as the format of results. The age-range in the studies was from 1.5 to 19 years (Table 1), however, the youngest self-reported estimations were from four-year-olds. Foster et al. (38) and Amougou et al. (17) reported that parents were asked to estimate portions sizes for children aged 1.5-4 years and 3-7 years, however, children in older age groups estimated their own portion sizes using an atlas, and thus the studies were included. Any studies that included the age group of interest, but in which the guardians estimated the portion sizes of all the children, were excluded (51). In Turconi et al.'s study (25), on participants aged between 6 and 60 years, the analyses were not carried out separately for different age groups. However, age was taken into account in the analyses whereas, in some cases, studies did not report the results of using the photographs separately for children and adults and they had to be left out of the review (20).

Some of the differences in the study design included, whether portions were served by researchers or by participants themselves, whether portions were just seen or also consumed by participants and at what point in time were participants asked to evaluate the portion size. The results of validation studies have been reported in many different formats, which posed a challenge when comparing studies. Results can be presented as the degree of error between the actual and estimated weights, estimation accuracy of the tool, percentage of overestimated, underestimated and correctly estimated food, or the percentage of participants who overestimate, underestimate or correctly estimate foods. Many of these aspects will be discussed below and in the next chapters. An overview of the results of these studies can be found in Appendix 1. The majority of studies were conducted in Europe (UK, Norway, Denmark, Belgium, Italy (12,25,28–30,34,37,38,41)), two in South America (Brazil and

Mexico (24,32)), two in Africa (Cameroon and Mozambique (17,27)) and one in Asia (Sri Lanka (31)).

Nine studies gave at least a brief description how portion sizes for the atlases or photographs were based on earlier weighed data of local children's or adolescents' portion sizes, thus portion sizes were age-appropriate for children and adolescents (12,17,24,27,28,31,37,38,41). Turconi et al. (25), Frobisher & Maxwell (29) and Biltoft-Jensen et al. (34) used pictures depicting adult portions and the same pictures were used for both adults and children, whereas in two studies, Vereecken et al. (30) and Brito et al. (32), it was unclear how portion sizes were determined and whether they were based on data of children's portion sizes.

Out of the fourteen studies selected, Frobisher & Maxwell (29) and Biltoft-Jensen et al. (34) concluded that the portion size photographs did not improve the portion size estimations of children or adolescents. Both Biltoft-Jensen et al. and Frobisher & Maxwell observed that an explanation for children's inaccuracy in portion estimation may be that the portion sizes were portions of adults and therefore, not applicable to children or adolescents. Turconi et al. (25) was the only other study to use photographs of adult portion sizes in addition to these two studies. Foster et al. (12) compared three separate validation studies of portion size photographs where one was performed on adults with adult portion sizes, one on 4-11-year-old children with adult portion sizes and one on children with applicable portion sizes for children. They found that the children who estimated their portion sizes with adult portion size photographs were not accurate, but the children who were given applicable portions to their age, were statistically just as accurate as adults in evaluating their portion size using photographs. This supports the view that portion sizes should be age appropriate.

Out of the fourteen studies, the other twelve studies found that portion size photographs, an atlas or computer-based pictures can be used by children and adolescents to estimate the food portion sizes more or less accurately (12,17,24,25,27,28,30–32,37,38,41). All of these studies, apart from Turconi et al. (25), used portion size photographs applicable to children or adolescents. However, there were differing results regarding the accuracy and precision of children's and adolescents' estimations. Some studies reported a high percentage of correct estimations or a small estimation error, while for others, the percentage of correct estimations was modest. Many studies highlighted that the ability of children and teenagers to choose the right portion size varied highly on an individual level (25,27,28,30,38,41). Hence, is important to recognise that using a photographic food atlas may not give accurate information on an individual level but can be used to accurately rank individuals according to their food intake and thus can be used in larger epidemiological studies.

Five of the studies included adults as well as children and four of them compared the accuracy of estimations between adults and children (12,17,25,29,34). Turconi et al. (25) did not report separate results for adults and children, but in their multiple regression analysis they found that results were independent of age. Foster et al. (12) and Amougou et al. (17) reported that children's estimates were not significantly different from those of the adults. That is to say, they were able to correctly estimate as many portions as adults. However, Biltoft-Jensen et al. noticed that though children had as many correct estimates as adults, they overestimated more, which made their mean estimation error larger (34). Frobisher & Maxwell reported that for children there were greater errors in evaluating portion sizes than adults using both food photographs and standard portion size description (29). As with Frobisher & Maxwell, many of the studies also compared photographs to other portion size estimation aids and these are discussed below.

2.2.2 Children and other portion size estimation tools

Various tools to aid children's and adolescents' portion size estimations have been tested in conjunction with portion size photographs including household measures, food models, interactive tools and line diagrams. Foster et al. (28) compared the accuracy of estimates using food photographs, food models and an interactive portion size assessment system (IPSAS) developed for children. Overall, children of all ages in the study (4-16 years) performed well when using the IPSAS and photographs. The accuracy and precision of estimates made using the food models were poor.

Bernal-Orozco et al. (24) compared the estimation accuracy of using a photographic food atlas to that of measuring cups and food models. A lower mean error percentage estimate was observed when using the photographic food atlas (2.3%) compared to using the food models (32%) and measuring cups (56.9%). Also 41.5% of estimations using the album had estimation errors of 20% or less, whereas the corresponding percentage for the food models was 29% and 20%. Thoradeniya et al. (31) also found that household utensils performed poorly when used to estimate portion sizes. However, they found that line diagrams gave a high percentage of correct estimations for non-amorphous foods but greater accuracy and precision for estimation of amorphous foods were obtained with small photographs.

Frobisher & Maxwell (29) asked children to assess portion sizes using photographs and standard descriptions of portion sizes that were defined as "small", "medium" and "large". Use of the food atlas was more likely to result in overestimated portion sizes than use of the descriptions. However, a comparison of the number of subjects who were within ±10 or 50% of actual weights and the range in individual differences using descriptions and the food atlas, showed neither method produced more

accurate results. It is also important to note that in the case of Frobisher & Maxwell's study, the portion sizes in the photographs were those of adults and perhaps not applicable to children.

Overall, it would seem that measuring cups, household utensils and food models produce less accurate estimations of portion size compared to photographic food atlases among children. They are also better in practical terms as they can be used to estimate amounts for more foods, require less storage space and are more portable and less expensive than having to produce food replicas (24). Photographic food atlases also have an advantage over computer-based portion estimation systems, as they do not require portable electronic devices, or need charging, which can be costly and challenging in the field.

2.2.3 Psychological processes

Photographic food atlases provide a useful tool for portion size estimation at a group level. However, big differences between individuals remain. Foster el al. (28) attributed these differences partly to individuals' varying cognitive development. As first suggested by Nelson et al. (33), the cognitive events that must take place in order for a person to be able to estimate their portion size from a picture are perception, conceptualisation and memory. The process of perception refers to a person being able to relate a quantity of food in reality (i.e. that they can see) to an amount depicted in a photograph. The process of conceptualisation refers to a person being able to relate a quantity of food that is not present to an amount depicted in a photograph. Memory plays a role in the accuracy of conceptualisation. These psychological processes – perception, conceptualisation and memory – are often referred to and taken into account in the design of validation studies of food atlases. Depending on the design of the study, it may test all, or a combination of participants' perception, conceptualisation and memory. In the study designs, in which participants are asked to evaluate the size of their portions with the portion present, perception is being tested. In the study designs, where participants are asked to evaluate the size of the portions after the portion has been taken away or is not present, conceptualisation and memory are being tested. In some studies participants are asked to evaluate their portion size immediately after seeing the portion size, which emphasizes conceptualisation, whereas in other studies, there may be a longer time period between seeing the portion and evaluating its size, which will emphasize the role of memory in conceptualisation.

There are benefits and disadvantages to each design. For example, a study focusing on perception will give information on how clear and decipherable the portion size photographs are in the food atlas, whereas the results of a study where participants are asked to recall their portion size after a longer period of time may test participants' abilities to remember rather than the actual clarity of the

photographs. However, studies asking participants to recall portion sizes after a longer period have more ecological validity as photographic food atlases are mostly used for retrospective documentation of portion sizes and therefore, consumed portion sizes will rarely be present. All study designs are needed to form a complete picture of the validity of a photographic food atlas.

Five studies of the fourteen measured perception only (12,24,32,34,41). In these studies, children were either asked to serve themselves a portion or were shown pre-served portions, which they were then asked to estimate the size of, using the photographic series. The portion sizes were present while the adolescent was evaluating the size. Pre-served portions could be exactly the weights depicted in the pictures or portion sizes in between depicted portion sizes. Vereecken et al. (30) examined both perception and conceptualisation as 128 adolescents estimated pre-weighed displayed portions (perception), and 72 adolescents self-served their usual portions and estimated the amounts later the same day (conception). Thoradeniya et al. (31), Turconi et al. (25), and Korkalo et al. (27) concentrated on measuring conceptualisation. It is arguable that the study design testing conceptualisation will also inevitably test memory, as memory affects the accuracy of conceptualisation. However, in the studies mentioned above, participants were asked to recall the portion sizes soon after seeing, or consuming the meal. In comparison, in four other studies the participants were asked to evaluate portion sizes soon after seeing or consuming it, but also at a later date, multiple days after seeing or consuming it (17,28,29,38).

Foster et al. (37) measured all three aspects of perception, conceptualisation and memory. Children were asked to evaluate portion sizes with food in front of them, immediately after eating the food and 24 hours after consuming the food. Foster et al. (37) found that the time of recalling the portion size did not affect children's accuracy or precision. Also Amougou et al. (17), Foster et al. (38) and Frobisher & Maxwell (29) found that the time of recalling the portion size did not have an effect on accuracy. This indicates that children are capable of memorising food portion sizes accurately. However, it was noted that, as participants had also been asked to evaluate the portion size immediately after seeing it, recalling of the portion size may have in reality been the recollection of a previous answer, rather than actually accurately recalling the portion size seen or eaten (29). However, no studies so far have found a connection between accuracy of estimation results and the time between the portion being seen or eaten and the estimation point. Thus, it would seem that children are capable of recalling portion sizes and are able to conceptualise a portion previously seen or eaten.

2.2.4 Participant features

Due to big individual differences in ability to accurately estimate portion size, studies have looked at various individual characteristics of participants to see whether they are associated with better estimation ability. Nelson et al. (52) originally suggested that age, gender and body mass index (BMI) are potentially important confounders when estimating food consumption, using eight portion size photographs. Nelson & Haraldsdóttir (53) go on to suggest that age, gender, weight and body mass index (BMI), education, occupation and culture will also affect ability to accurately estimate portion sizes.

Age is a common determinant that has been taken into account in many studies. Frobisher & Maxwell (29) reported that for subjects aged 16 years and under, there seemed to be greater errors using both words to describe the food portion and the food atlas to determine portion sizes than in the older subjects aged 17 years and over. Foster et al. (28) validated food portion photographs for children aged 4-16 years and reported that both accuracy and precision improved with age for all methods of portion size estimation and for both foods served and consumed. They noted an increase in the accuracy of estimates between the ages of 7-11 and 11-14. Thoradeniya et al. (31) validated portion size estimation aids including food portion photographs for children aged 10-16 years. In contrast, they found that age (two groups <12 and ≥12 years) was not associated with correct or incorrect estimations while using the photographic food atlas. Turconi et al. (25) validated a colour food atlas on volunteers aged 6-60 years. They also found that estimations were independent of age. However, Korkalo et al. (27) validated food portion pictures in Mozambique for girls aged 13-18 years and found that there were no significant differences in the proportions of participants between the estimate categories for staple foods or sauces with regard to age. Brito et al. (32) found that the percentage of adolescents who were able to recognise all foods was higher in adolescents aged 15-18 years compared to those aged 11-14 years. However, there were no statistically significant differences in the number of portion sizes correctly identified in the photographs according age group. Lillegaard et al. (41) also found that for most food items, no significant differences existed between the 9-10, 13-15 and 16-19-year-olds' abilities to choose the correct photograph in the atlas.

Foster et al. (28) discussed theories of children's development of size perception. Children are believed to develop the perception of size and understanding of conservation around the age of 7 years. Conservation is the ability to recognise that a size or quantity remains the same when the appearance of the object changes. Out of all the studies, Foster et al. (28) is the only one in which children aged 7 years or less and children aged 7 years or more, were compared. In all the other studies, apart from Turconi et al., all children were over 7 years, which may mean that they had all

already developed the cognitive processes to be able to perceive size. In Turconi et al.'s study (25), participants were divided into age groups of 6-11, 12-19, 20-40 and 41-60 years. They found that estimation accuracy was independent of age and suggested this may have been due to the small amount of under seven-year-olds in the study sample.

Ovaskainen et al. (39) found that the overall reporting error for men using a photographic food atlas was -10 grams and +1 grams for women and Nelson et al. (33) found that being female was associated with small but significant overestimations of portion sizes. Research indicates that both overweight adults and children often underestimate their food intake (7,54). For this reason, children's gender and BMI have been theorised to have an association with estimation accuracy. However, there is limited research on how gender and BMI may affect estimation accuracy amongst children and adolescents. Thoradeniya et al. (31) found that gender was not associated with correct or incorrect estimations while using the photographic food atlas among participants aged 10-16 years. Turconi et al. (25) found that estimations were independent of gender and BMI in participants aged 6-60 years. According to Brito et al. (32), there were no statistically significant differences in being able to recognise the foods in the photographs according to gender and weight status, nor were there statistically significant differences in the number of portion sizes correctly identified in the photographs according to gender or weight.

Education level as well as literacy and numeracy skills have also been hypothesised to be associated with accuracy of estimation of portion sizes (40). Korkalo et al. (27) found that there were no significant differences in the proportions of participants between the estimate categories for staple foods or sauces with regards to school attendance. So far, there is little evidence to indicate that gender, BMI or education level could be associated with estimation accuracy, though more research may be needed. Foster et al. (28) stated that there seems to be little evidence for any correlation between socioeconomic status (SES) and basic pattern vision (the psychological process that enables recognition of shapes) and hence expect no differences in size perception between different SES groups.

2.2.5 Kenyan context

To our knowledge, there is no photographic food atlas in Kenya for adults or adolescents. According to informal statements made by Kenyan nutritional professionals, a South African food atlas for adults (18) has been used, but it is not always applicable to the Kenyan context as it lacks some essential foods and includes foods that are not relevant to the Kenyan context. Partly due to this, and also due

to the fact that it included multiple line diagrams of foods, it was also considered quite bulky for field work.

Thoradeniya et al. (31) found that line diagrams gave more accurate estimations of portion sizes for non-amorphous foods but small photographs gave more accurate estimations of amorphous foods. Many Kenyan staple foods are of amorphous texture and do not have a clear outline, for example *ugali* (stiff maize flour porridge), *Sukuma Wiki* (fried collard greens), bean, lentil and meat stews, rice dishes (white rice, *pilau*), *uji* (runny fermented porridge) and *mukimo* (mashed potato and green vegetables). Hence, food portion photographs can be a useful tool to aid children and adolescents in portion size estimation. Though Kenya has high mobile device usage across the country (55) and interactive computer- or technology-based portion size assessment systems have been proven to produce accurate estimations of portion sizes (38), a physical paper photographic food atlas may be more practical in the field. An interactive system based on a computer or portable mobile device would also require access and resources for computers and portable mobile devices as well as access to power and possibly the internet, which may not always be possible in the field. The use of portable mobile devices has increased in recording survey data in Kenya. It would require having an additional portable mobile device to present the interactive user system, or having to switch between the survey and the photographs on the one device, which is not practical. Paper versions of the photographic food atlas are cheap to reproduce and easy to carry in the field as well as reliable. Therefore, a photographic food atlas is still a relevant tool to be developed for portion size estimation, especially in the Kenyan context.

Of the studies introduced above, Amougou et al. (17) and Korkalo et al. (27) explored the accuracy of using portion size photographs for children and adolescents in other Sub-Saharan African countries (Cameroon and Mozambique). Amougou et al. (17) examined the ability of 3-7-year-olds' guardians to evaluate their children's portion sizes and 8-13-year-olds to evaluate their own portion sizes in Cameroon's capital city Yaoundé. Two-hundred and twenty four children participated and it was found that children accurately estimated 74% of 556 portions (17). Small and medium size portions were frequently selected and accurately estimated (>70%). Children were also able to remember their portion sizes accurately over time. Amougou et al. (17) found that the visual aid used to identify portion sizes could generate a true picture of an adult's and child's energy and nutrient intake in Cameroon.

Korkalo et al. (27) examined the ability of ninety-nine adolescent girls aged 13-18 years to estimate their portion sizes in the surroundings of the coastal town of Quelimane in Mozambique. Five photograph series of two staple carbohydrates and three sauces were tested and mean differences

between estimated and actual portion sizes relative to the actual portion size ranged from 219% to 8% for different foods. Larger portions of the staple foods were often underestimated. The proportions of participants who were able to give estimates within ±10 % of the actual portion size were somewhat modest, ranging from 20 to 38 % for different foods. The ability to rank individuals according to their consumption was, however, satisfactory for most foods. Korkalo et al. also found no significant differences in the proportions of participants between the estimate categories for staple foods or sauces with regard to school attendance.

Based on these results of validating food portion photographs among children and adolescents and similar results in studies conducted amongst adults in other Sub-Saharan countries (18,26,44), it seems that a photographic food atlas could be a feasible portion size estimation tool amongst Kenyan children and adolescents in Nairobi.

2.3 Adolescent nutrition in Kenya

2.3.1 Nutrition status

Adolescents are an often-forgotten demographic group in the field of nutrition. There is a lack of research and information on the nutritional status of adolescents globally and especially in LMICs (7,56).

There is very limited nationwide information on adolescent nutrition status in Kenya. Kenya's largest nationwide health study, the 2014 Kenya Demographic and Health Survey (2014 KDHS) (57) focuses on the nutrition status of infants and women which have long been research priorities world-wide (58). Though there is no section dedicated to adolescent health or nutrition status in the 2014 KDHS, some data on adolescent girls aged 15-19 years was included due to their high pregnancy rates.

Adolescent girls aged 15-19 years are the most malnourished group among women of reproductive age in Kenya, 17% have a BMI of less than 18.5 compared to the 9% of women aged 20-29 years and 6% of women aged 30-39 years (57). Out of all the age groups of women, 15-19-year-olds are least likely to be overweight or obese. Only 12% of 15-19-year-old adolescent girls were overweight or obese (BMI $\geq$ 25), whereas 29% of 20-29-year-old women and 48% of 40-49-year-old women were overweight and obese. Undernutrition is clearly still an issue in Kenya, especially among adolescents, but overweight and obesity is also a growing concern, with such high prevalence in older women.

Little to no, national-level data is available on adolescent boys' nutrition status in Kenya. Mwaniki & Makokha (59) reported that in their study of 208 4-11-year-old children in Dagoretti in Nairobi (a low-income area), 25% presented stunting, 15% were overweight and 10% presented wasting. They

reported that boys had a higher rate of stunting and underweight compared to girls, but girls had higher rates of wasting. However, none of these differences were significant. Similarly, Semproli & Gualdi-Russo (60) reported that 5-17-year-old boys in a rural area of Western Kenya presented lower Z-scores than girls and there were higher percentages of stunted and underweight subjects among the males. The degree of malnutrition appeared to be higher in boys than in girls during puberty, which, they said, is in line with previous studies conducted in Sub-Saharan Africa. They noted that adolescents (11-16 years) showed the most severe undernutrition, but the emerging problem of over-nutrition was also evident among both boys and girls under eight and girls in all ages.

However, there were differences between regions in Kenya as, out of all the areas, Nairobi had the lowest proportion (3%) of women aged 15-49 who are thin (57). According to the Kenya STEPwise Survey for NCDs Risk Factors (61), the proportion of overweight and obese women was higher in urban areas (43%), compared to rural areas (26%), but even in the rural areas it is steadily rising. Thus, the limited evidence seems to point towards a trend of increasing overnutrition especially in urban areas and amongst girls and women, resulting in Kenya being faced the triple burden of malnutrition.

2.3.2 Most commonly consumed foods and portion sizes

Assessment of dietary and nutrient intake is one of the most widely used indirect methods of establishing nutritional status. Though there is no nationwide study of the nutritional status of adolescent in Kenya, there are separate studies reporting nutrient intake amongst Kenyan adolescents (60,62,63), yet very limited studies that report the foodstuffs consumed and typical portion sizes. When developing a photographic food atlas, data on the dietary intake at the foodstuff level is of interest. Data on the most commonly consumed foods, food portion sizes and other dietary habits in the target population is needed. There is no national database for the most commonly consumed foods and portion sizes for adolescents, or even adults in Kenya.

Three studies were found detailing the daily amounts of the most common foods consumed in weights, or frequency amongst Kenyan children and adolescents (59,64,65). Foods were not categorised into the same food groups in the different studies, so results are not entirely comparable. In addition, the study settings, designs and ages of the children differ. However, in all studies, starchy staples (cereal grains and in some cases tubers) were the food group consumed the most, in terms of weight and frequency daily over a 6-month period. The foods mentioned in this food group were *ugali*, rice, *chapatis* (pan-fried flat bread), bread, porridge, *githeri* (maize and bean mixture), and plantain. Mwaniki & Makokha (59) reported the average daily consumption to be 358 grams for

children aged 4-11 years in Dagoretti, Nairobi whilst Gewa et al. (64) reported the average daily consumption to be 515 grams for children with a mean age of 7 in a rural setting in the Eastern Province of Kenya.

Mwaniki & Makokha (59) reported legume grains (beans, green grams and lentils) as the food group with the second highest daily amount consumed (293 grams), whereas Gewa et al. (64) reported legumes and nuts (dry kidney beans) to be the food group with the third highest daily consumption, at 91 grams. Gewa et al. (64) reported vitamin C rich fruits (oranges, lemons, papaya) and vegetables as the second most consumed food group in weight (101 grams). Vegetables (cabbage, *Sukuma Wiki*, spinach, cowpea leaves, bean leaves, carrots, onions, mushroom, tomatoes) were reported as the third most consumed food group in weight by Mwaniki & Makokha (59). Gewa et al. reported that school children's mean daily intakes of dark green leafy vegetables (kales, cowpea leaves), vitamin A rich fruit and vegetables (mango), other fruit and vegetables (avocado, onions and green beans) and meat, fish, poultry and eggs were below 50 grams. Dairy products (fresh or fermented milk) consumptions of 188.2 g/d (59) and 88 g/d were recorded (64). It is important to note that the daily average is not equivalent to portion sizes, but portion sizes can be compared to these figures when other data is not available.

Masibo (65) reported the frequency of different food groups consumed by school children aged 6-13 years in the Millennium Villages Project in Siaya, Kenya. The most frequently consumed food within the last 6 months was staple starches. Vegetables were the second most consumed group and fruits the third most consumed group in frequency (65). After that came meat, fish and poultry, sugars, nuts and seeds and roots and tubers in descending order of frequency. Other resources found that reported typical Kenyan dishes and serving sizes were the National Guidelines for Healthy Diets and Physical Activity (4) and the Kenya National Clinical Nutrition and Dietetics Reference Manual (66). However, serving sizes are not the same as actual portion sizes and it is unclear how the set serving sizes have been determined in the documents; whether they were based on actual portion size research, or have been decided based on practicalities is not stated. The weight of one serving of grains, roots, tubers, starchy fruits, meats and fish is 30 grams. In most cases of the carbohydrate source, this 30-gram serving has been defined as half a cup, whereas the size of a meat serving is described as a matchbox or three fingers and fish as palm size. The serving size for vegetables is 80-150 grams which is deemed to be the weight of a whole cup of raw vegetables, or half a cup of cooked vegetables. One dairy serving is defined as 250 millilitres.

2.3.3 Dietary habits

None of the research reporting daily consumed amounts of foods mentioned consumption of fast food. However, in a qualitative study by Ssewanyana et al. (67) of Kenyan adolescents (10-19 years) in Kilifi county on the coast (peri-urban to rural), it was found in 72% of the focus group discussions (FGDs) and 90% of the key informant interviews, that deep fried potatoes and potato chips were discussed as commonly consumed by adolescents. Likewise, in 55% and 70% of the FGDs and key informant interviews respectively, commercially processed juices and sugar-dense confectionaries, such as cakes, sweets, and ice-cream, were discussed. A primary school teacher interviewed as a key informant said that instead of the children buying *ugali* and beans, they could be found buying "a bottle of juice made from that chemical [referring to a certain brand of processed juice] and deep-fried potatoes". As Ochola & Masibo (7) reported, traditional diets in LMICs are being replaced by diets characterised by consumption of high-calorie foods, high in sugar, saturated fats and salt, for example, bread, cookies, sweets, soft drinks, ice cream, sweetened beverages, sausages, cheese, and canned foods. This is especially visible in the urban settings.

According to Ochola & Masibo (7) breakfast was often skipped or rarely eaten by schoolchildren in many different developing country settings, especially in the rural areas. In Kenya's neighbouring country Uganda, a study found that even where breakfast was consumed, it often consisted of a plain cup of tea with milk, millet porridge or leftover food from the previous evening (68). Mwaniki & Makokha (59) reported that breakfast contributed the lowest mean energy intake for the day (11%) amongst children in orphanages on the outskirts of Nairobi City, whereas lunch (44%) and supper (45%), contributed larger and equivalent proportions of mean energy intake. Mwaniki & Makokha (59) reported that their findings were similar to those found in a micronutrient survey, which reported a relatively low consumption of fruits. Also in another sub-Saharan country, Ghana, 56% and 48% respectively reported that they rarely ate fruits and vegetables (69). Nevertheless, as mentioned above, Gewa et al. (64) reported a high intake of fruits rich in vitamin C in the Eastern Province of Kenya.

3 Aims

The aim of this thesis was to develop a photographic food atlas for 9-14-year-old Kenyan adolescents in Nairobi according to the scientific protocol explained above. The second aim was to test the usability of the atlas amongst both adolescents and nutrition professionals. Hence the guiding research questions that will help achieve these aims are: *how to develop a photographic food atlas* and *what is the usability of the photographic food atlas amongst the end-users both adolescents (9-14 years living in Nairobi) and nutrition professionals*? The supporting questions are: *what are the most common foods consumed by 9-14-year-olds in Nairobi* and *what are their average portion sizes*. These supporting questions will help guide the development of the photographic food atlas specifically for the Kenyan context, as well as form a basis for the questions in the usability questionnaire.

How to develop a photographic food atlas and what affects its validity were reviewed and discussed in the literature review. The theory and knowledge outlined in the literature review was used to guide the methodology of developing this photographic food atlas. The usability of the atlas was tested in a survey conducted for both the adolescents and the Kenyan nutrition professionals. The aspects investigated in the usability survey were based on what was found to be relevant to usability and what is considered to be relevant for estimation accuracy in the literature. Specifically, it was important to ensure that the most commonly consumed foods were included and that portion sizes were applicable for the age group in question.

The atlas was developed for a larger research project being undertaken by the KENFIN-EDURA educational capacity-building project, between University of Helsinki and Kenyatta University. In this research project, the diet, physical activity and weight status of adolescents and their parents in the context of socioeconomic status and place of residence was examined. The diet of participants was measured with a semi-quantitative 7-day FFQ. This master's thesis entailed the development of a photographic food atlas to be used as an aid for children and adolescents whilst completing the FFQ to determine their dietary intake.

4 Methodology

4.1 Study design and area

Nelson & Haraldsdóttir's (13) five-step theory of developing the atlas was applied in the planning of the research. The preliminary preparations included Steps 1-3 of the theory, a steering group was formed, consisting of Kenyan and Finnish nutritionists and sociologists (KENFIN-EDURA research project members), Kenyan nutrition professionals were consulted and the relevant literature was reviewed (Figure 1). Field research was planned consisting of three phases.

The First Phase of the research consisted of visits to households with 9-14-year-old children in order to weigh their portion sizes and identify the most commonly consumed foods, constituting the third step of Nelson & Haraldsdóttir's (13) theory. The Second Phase in the field research consisted of the cooking demonstrations and development and printing of the photographic food atlas. The steering group made the selections of which foods to include and how to present portion sizes based on the data collected in the First Phase, this represented the fourth step in Nelson & Haraldsdóttir's (13) theory. The Third Phase of the field research consisted of a usability survey of the atlas, which involved consulting the children and the Kenyan nutrition professionals on their opinions, constituting the fifth step in the theory. The steering group was consulted throughout the research process and the edits implemented in the second version of the atlas were discussed with the steering group. The end-result was a second improved version of the photographic food atlas.

Many of the activities within each step were based on the model of Lombard et al. (26), who used quantitative and qualitative methods to develop a photographic food atlas in South Africa. The cooking demonstration was similar to the dishing-up sessions they used. The plan to collect qualitative as well as quantitative data and consult both local nutritional experts, as well as children was also inspired by their consultations with the expert panel and FGDs with local women.

For the field research, two study areas within Nairobi County were selected to represent two different SES groups present within Nairobi. The ward Nairobi West within the sub-county of Langata was chosen to represent middle SES, and the ward Kayole within the sub-county of Embakasi Central (henceforth referred to as Embakasi) was chosen to represent low SES. The research started with obtaining the research permit from Nairobi County. After obtaining the permission, local health centres in Langata and Embakasi were approached to discuss the facilitation of our fieldwork with community nutritionists and community health volunteers (CHVs). While waiting for the research

permit to be accepted, the field research materials, such as the weighing scales were acquired and the questionnaire forms were prepared.

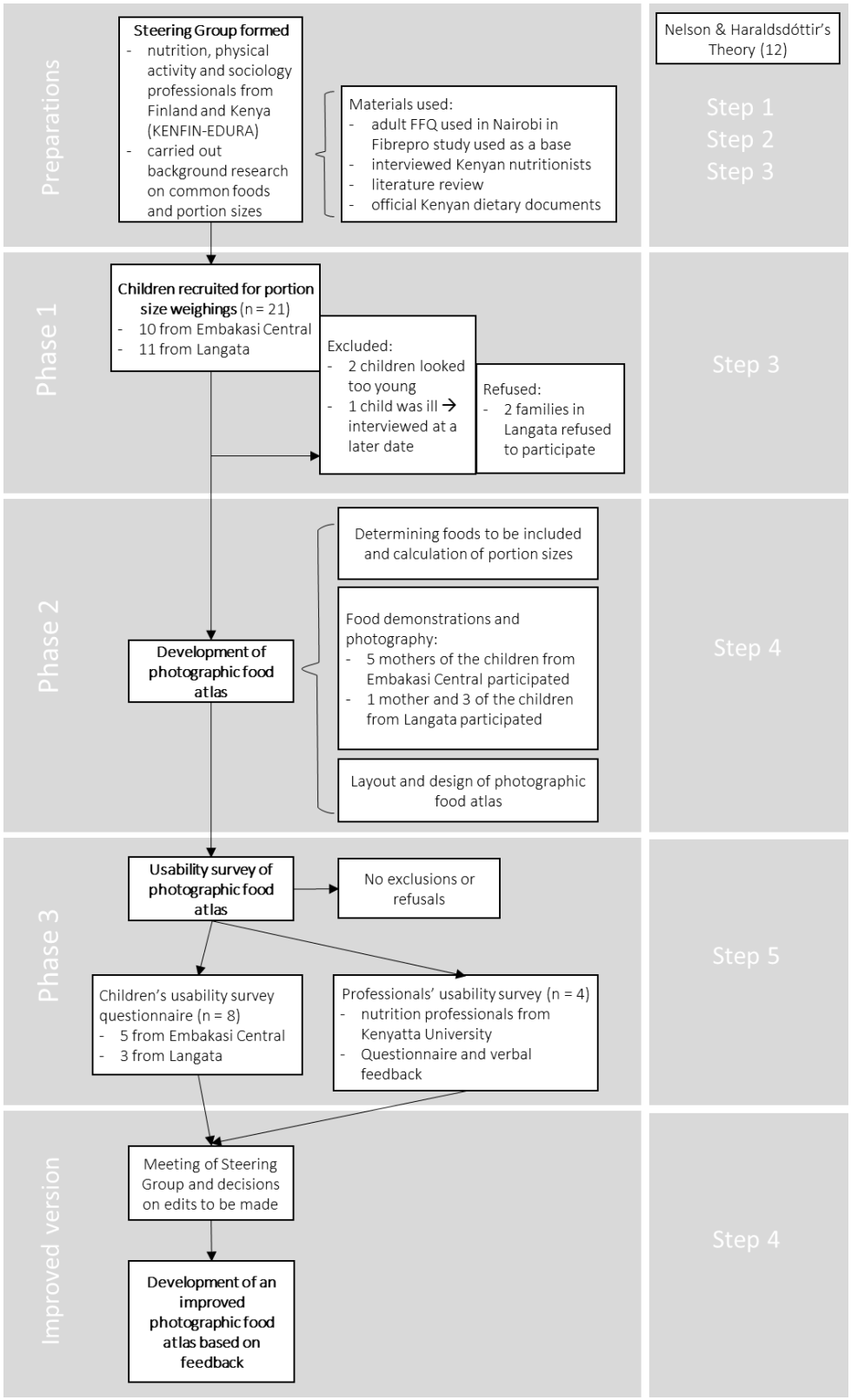

Figure 1. Flowchart of the study process. Step 1: Form a steering group, Step 2: Consult widely, Step 3: Use population-based data on types of food and ranges of portion sizes commonly consumed, Step 4: Select foods to be included, Step 5: Repeat step 2 – consult widely.

4.2 Development of questionnaires

Study information and consent form

All parents of adolescents involved in the study (in both the First and Third Phase) were given an information form at the beginning of each visit (Appendix 2 and 3). The information form included details on the purpose of the study, what was required from the adolescent if they participated, as well as contact details of the research leader. Parents of the adolescents were also given a consent form to sign (Appendix 4 and 5). The consent form specified that participation was voluntary and that parents had the right to withdraw their child from the study whenever they wanted, without the need to provide a reason and no repercussions. The content of the consent form was read out to all parents. Not all parents were able to sign the consent form, in which case verbal consent was accepted. The forms were written in English and Kiswahili and participants could choose which forms they preferred.

Background information questionnaire

The background questionnaire was formulated with the help of my supervisor Dr. S. Ochola, making use of her previous experience in drafting background questionnaires, and it was also commented on by the rest of the steering group (Appendix 6). The background information questionnaire was filled in by the interviewer and was completed for adolescents in both the First Phase and the Third Phase. Questions on the background information questionnaire included the adolescent's and guardian's name and address, or mobile number for contact details, the birthdate of the child, gender of the child, number of siblings and education level. The residential area was noted down as was the type of dwelling. In addition, parents' education levels and occupations were also recorded on the background information form.

Food frequency questionnaire (FFQ)

The semi-quantitative FFQ was administered by the interviewer during the Third Phase whilst conducting the usability survey. The FFQ was originally formulated by the Fibrepro research group (70), a collaboration between the University of Helsinki, Portuguese Catholic University, University of Nairobi and Institut de Recherche en Sciences Appliquées et Technologies, Burkina Faso, for their research on adults' dietary intake in Nairobi. The research has not yet been published. Some foods were added to the Fibrepro FFQ by the steering group after consulting Kenyan nutrition professionals including noodles (often referred to with brand name 'indomie'), bean leaves, green peas, eggplant, okra, cauliflower, broccoli, other poultry (turkey, duck), rabbit meat, game meat, offal (liver, heart, kidney, lungs, spleen), insects (grass hoppers, termites), goat milk, other types of milk (plant-based:

coconut, soya), cream, ghee, sunflower oil, coloured ice (also with sugar), candies, milkshakes, *biriyani* (a spicy rice dish) and meat pies. Some additions were also made, based on the most commonly mentioned foods by the adolescents and the food found on the markets in the First Phase, these included *matoke* (plantain stew), arrowroot, *bhajia*, guava, tree tomato, peaches, pizza, burger, *kachumbari* (fresh tomato and onion salad), hotdog, toasted sandwich, rice and bean mixture as well as a mixture of rice, potato and carrots. Alcoholic beverages such as beer and wine were left in the FFQ as we had no knowledge as to whether the consumption of these are common in adolescents.

The foods were rearranged slightly between the different food groups from the original Fibrepro FFQ and tubers were separated from the cereal and grain products. The frequency and portion size of 159 food items were asked in the following order: cereal and grain products (20); tubers (7); vegetables (27); legumes, pulses, seeds and nuts (5); fruits (18); meat, fish and eggs (20); dairy products (9); fats and oils (9); sauces, seasoning and flavouring items (7); sugar, syrup and sweet products (11); beverages (11), and composite dishes (14) (Appendix 7). The frequencies of food consumption were categorised in the following order: never, 1-3 times per month, 1 time per week, 2-4 times per week, 5-6 times per week, 1 time per day, 2-3 times per day, 4-6 times per day, 6+ times per day. The size of the portion was indicated by checking either size S (A=small), E (B=medium) or B (C=large).

Usability survey questionnaire

Various guides were consulted to understand the theory of how to test the usability of an item, how to use the Likert scale and what sort of questions should be asked (71,72). According to the International Organisation for Standardisation, the definition of usability is "the extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" (72). The various aspects of usability are defined as efficiency, intuitiveness, ease and satisfaction. To test these aspects of the products usability, a System Usability Scale (SUS) has been invented as a quick and crude measure consisting of ten predefined Likert scale questions with points given from one to five, representing the scale of agreement from strong disagreement to strong agreement (73,74). Half of the questions are worded in a positive form ("*I thought the system was easy to use*") and half in a negative form ("*I found the system unnecessarily complex*") and it is possible to calculate a Usability Score using a set formulae (75). However, for the purpose of this study, the questions in SUS were deemed too generic and it was thought that alternating positive and negative wordings may confuse the children.

For this study, it was important to ask children specific questions related to the foods and portion sizes presented in the photographic food atlas. The different aspects of usability (efficiency,

intuitiveness, ease and satisfaction) were kept in mind and the SUS questions were also used as a guide when developing the questions for this study. The usability survey questionnaire for the adolescents was developed for the purpose of this study and consisted of nine Likert scale questions with additional clarifying questions and three open-ended questions (Appendix 8). The questions were designed to obtain information on how the adolescents found using the photographic food atlas, whether they could use it by themselves, whether they could differentiate between the different foods and portion sizes and whether the portion sizes were of a correct range, aspects that were found to be relevant to the usability and validity of the atlas in the literature review. The steering group reviewed the questionnaire and gave suggestions for improvement. As in the SUS, the Likert scale was from one to five, one representing strong disagreement, five representing strong agreement and three meaning the participant neither disagreed, nor agreed. An adjusted Usability Score was formulated for this study (described in section 4.7 Data analysis).

The professionals were given a similar usability survey questionnaire to fill in (Appendix 9). It consisted of nine Likert Scale questions with additional open-ended questions, prompting them to elaborate their opinion. In the questionnaire, professionals were asked questions on the layout and design of the photographic food atlas as well as the range of portion sizes and range of foods. In addition, they were asked about the contents and order of the food atlas and whether they would use it in their own work or research. Professionals were given space to write down further suggestions and comments.

4.3 Participants

Adolescents were recruited via the help of a CHV. A convenience sample was selected to best represent the different ages and genders. The aim was to select ten adolescents aged 9-14 years from both Embakasi and Langata (twenty in total) for the household visits in the First Phase. For the Third Phase the aim was also to select another ten adolescents (different from the First Phase) aged 9-14 years from both Embakasi and Langata (twenty in total) to answer the usability survey. Only one child per household was interviewed, so no siblings were accepted to participate. If children were unwell and not eating, a later visit was scheduled. Age was verified by asking for date of birth and where applicable, checking a possible birth certificate or identification. Children turning nine during 2018 or older were accepted and adolescents no higher than the age of 14 at the time of the interview were accepted. When the participants were suspected to be younger or older than the defined age group, the visit was discontinued, and the research group moved on to the next household.

Henceforth, I will refer to the participants of my study as adolescents, as the age group overlaps for the most part with the World Health Organisation (WHO) definition of an adolescent (10-19 years) (50). I would like to highlight, however, that the participants would best fall into the category of middle years (7-10) or early adolescent (11-14) years as defined by UNICEF (76) and that the use of the term "adolescent" should not be interpreted as the participants having already undergone puberty. In this case, the term adolescence is used to emphasize that the participants of this study are on the cusp of adolescence and to differentiate them from children in their younger years.

4.4 First Phase – Weighing of portion sizes

The First Phase consisted of household visits in Embakasi and Langata to identify the most commonly eaten foods and weigh their portion sizes. The research team arrived at the households before mealtimes (breakfast, lunch, dinner). First, the research team was introduced by the CHV and then they introduced themselves and the purpose of the visit. The guardians were given the study information form and consent form in the desired language (English or Kiswahili). After obtaining verbal or written consent, the adolescents were then interviewed according to the background information questionnaire. In some cases, foods had been prepared beforehand and, in some cases, food was cooked whilst the research team was there. The recipe was noted down based on watching the guardian cook, or on their report of ingredients. While mothers were preparing the meal, the digital kitchen weighing scale (Ramtons, max 5000g) was set up on a level surface and calibrated with a 200g bag of salt. Adolescents were asked to show their most commonly used kitchen utensils and plate for serving the meal. The guardian or adolescent was then asked to serve the food onto a plate or bowl after which the portion was weighed. After the adolescent had finished eating, the plate or bowl with any possible leftovers was weighed and the weight was then subtracted from the entire weight of the food and plate. Adolescents were asked about the foods they most commonly ate at each mealtime and in school, and they were recorded along with approximate portion sizes. A market survey was conducted at the local markets to obtain information on the foods mentioned by adolescents. Street vendors were asked for their recipes and the most common portion sizes. Multiple pieces, or portion sizes of the various foods were weighed with the digital weighing scale to gain an average weight for market foodstuffs.

4.5 Second Phase – Development of food atlas

4.5.1 Selecting foods to be included

Various resources were used to glean an understanding of which foods are part of a typical Kenyan diet and which of them should be included in the photographic food atlas, as suggested by Nelson & Haraldsdóttir (13). Firstly, the purpose of the photographic food atlas was to be used as a tool to fill in the semi-quantitative FFQ in later research for KENFIN-EDURA. Hence, the FFQ was examined and the most important foods mentioned were included in the photographic food atlas. As mentioned before, the FFQ was developed for Kenyan adults in Nairobi, by the Fibrepro research group, and thus it already included the majority of foods typical for an urban Kenyan diet. The additions made to the FFQ by Kenyan nutrition professionals, the most commonly consumed foods by adolescents (Phase 1) and the local market survey (Phase 1), were taken into account.

In addition, previous research on the topic was checked in the literature review. There was limited research detailing the most commonly eaten foods and portion sizes of Kenyan children and adolescents, but three studies were found, detailing daily amounts, or frequency of daily consumption (59,64,65). These studies were used to confirm and corroborate decisions as to which foods should be included. The reports, National Guidelines for Healthy Diets and Physical Activity and the Kenyan National Clinical Nutrition and Dietetics Reference Manual, were also referred to (4,66). The steering group reviewed the list of foods to be included in the first draft of the photographic food atlas (Appendix 10).

4.5.2 Defining the average portion sizes

Because the photographic food atlas was to be used as a tool for determining portion sizes for the FFQ, the first version of the atlas was developed to contain three portion sizes. The original semi-quantitative FFQ developed by the Fibrepro research group included three portion sizes S (smaller), E (equal) and B (bigger) (70). These were based on a previously determined standard portion size, which had been calculated based on weightings from 11 households, 1 restaurant and 3 canteens. However, different foods were weighed in each place, based on availability. Some foods were also bought in the supermarkets and street markets and weighed. For the items they could not weigh, they used standard sizes of validated Portuguese manuals. The standard size was defined as E. The smaller size (S) was defined as the standard size multiplied by 0.75 and the bigger size (B) was one and a half (1.5) times bigger than the standard size.

Three portion sizes were calculated for most of the food items in the photographic food atlas so it would correspond with the FFQ. The portion sizes were labelled as A, B and C (S, E, B respectively) so as not to influence a person's opinion of the portion sizes. For some foods, three average portion sizes were not obtained and only one or two portion sizes were provided based on the package size, or the weight of an individual piece of food. The aim was to catch a large range of portion sizes from Kenyan adolescents, therefore, we did not use the same calculation formula as the Fibrepro team. Instead, food portions were calculated as described by Nissinen et al. (42); for most amorphous foods, portion B was the average portion size. This was determined by calculating the average of all the weighed portions consumed by the adolescents. Portion A was half (0.5) of portion B and portion C was one and a half (1.5) times bigger than portion B. In most cases, the mean was calculated and then rounded to the closest integer after which Portion A and Portion C were calculated. The portion sizes of foods that come in clearly defined individual pieces or packages, for example bread or fruits, were not always calculated according to this formula and may have a different ratio between the portion sizes. These were based on what was observed during the household surveys and on practicalities.

4.5.3 Cooking demonstrations and photography

Two cooking demonstrations were arranged in a local space, one in Embakasi and one in Langata. The cooking ingredients and utensils were provided, and five mothers of the ten adolescents interviewed in Embakasi in the first phase were invited to come and prepare the foods. Recipes were noted down, and portions were weighed using the Ramtons digital weighing scale according to the calculated portion sizes A, B and C for photography.

When portion sizes for certain foods were missing, during the cooking demonstrations in Embakasi, mothers were asked to show how much they would serve their adolescents. Based on these estimates made by the mothers, the average portion B was calculated on the spot, as well as the portions A and C according to the formula mentioned above.

During the cooking demonstrations in Langata, previously interviewed adolescents and their parents were invited to participate. Three adolescents attended with their guardians and were asked to show how much they would take themselves of the foods that it had not been possible to cook, or obtain weights for in Embakasi, as the foods were not commonly consumed there. Based on the servings of the adolescents, an average portion B and then portions A and C were calculated on the spot according to the formula mentioned above.

A photography point was set up at both cooking demonstrations and white table clothes placed on the table and behind the table for a neutral background. By setting up a photography station, the aim was to control the photography conditions and keep the lighting and the background constant. All foods were displayed on the same white plate and photographed with a Canon EOS 600D. The distance of the camera was aimed to be kept the same and the angle of photography was kept at approximately 45°.

4.5.4 Layout and design

David Mubasu, a graphic designer at Kenyatta University, compiled the photographic food atlas, using the Adobe InDesign CC programme. Portion sizes of 88 food items were included in the first draft of the photographic food atlas. Foods were organised based on the food groups in the FFQ and presented in the same order: cereal and grain products; tubers; vegetables; legumes, pulses, seeds and nuts; fruits; meat, fish and eggs; dairy products; fats and oils; sauces, seasoning and flavouring items; sugar, syrup and sweet products; beverages, and composite dishes.

Four food items were displayed on one A4 page of the atlas (Figure 2). The three portion sizes A, B and C were all placed next to each other starting with the smallest portion on the left. The name of the food in English and Kiswahili were displayed above the pictures of each food item. Each portion size A, B or C was also included above the picture and the weights of each portion were displayed slightly above that. A table listing all the weights of foods was included at the back of the atlas.

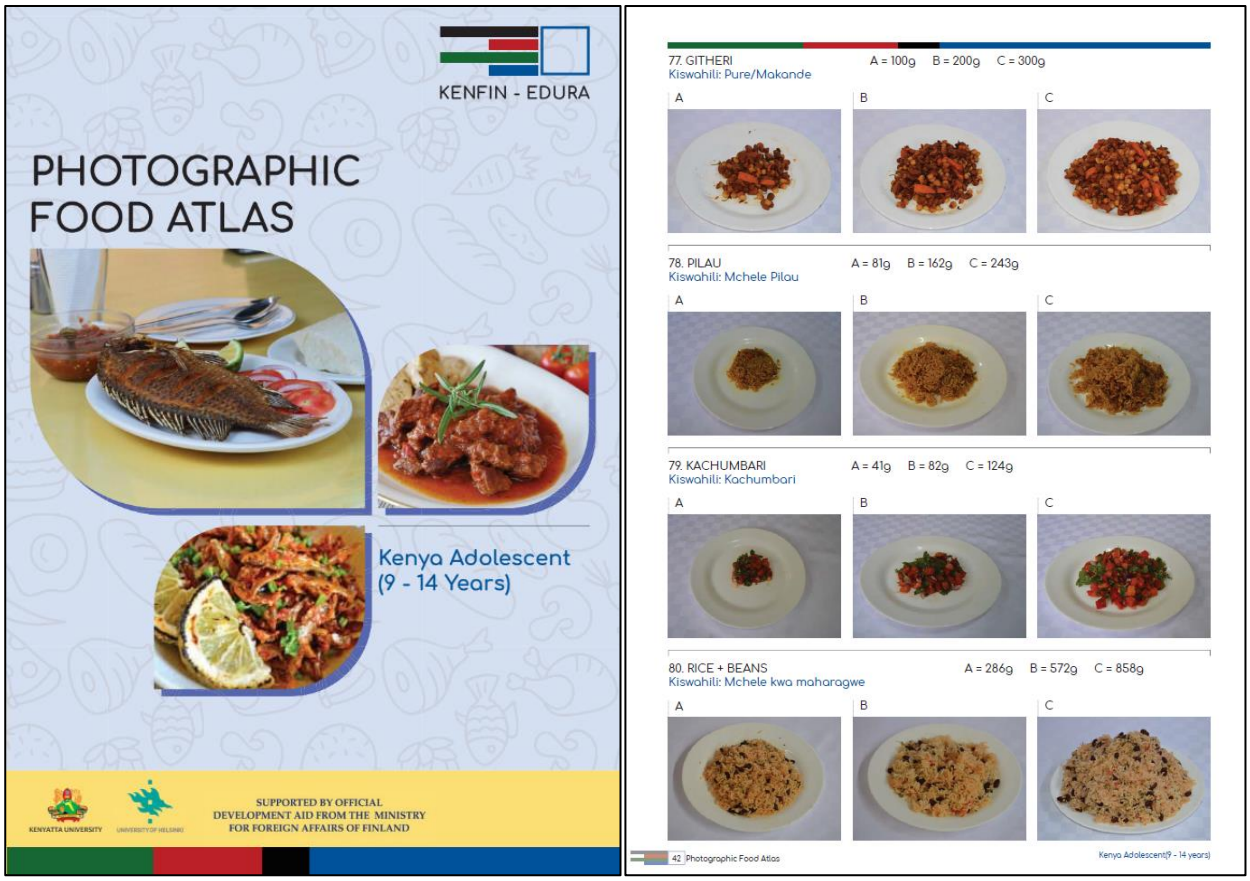

Figure 2. Cover (left) and page 42 (right) of the Photographic Food Atlas developed in the Second Phase.

4.6 Third Phase – Usability survey

Adolescents

The research team was introduced by the CHV and they then introduced themselves and the purpose of the visit. The guardians were given the study information form and consent form in the desired language (English or Kiswahili). After obtaining verbal or written consent, the adolescents were interviewed according to the background information questionnaire. Adolescents were then given the photographic food atlas. One interviewer was responsible for filling in the semi-quantitative FFQ whilst the other interviewer asked the adolescent the questions on food consumption frequency and guided them in using the photographic food atlas in order to estimate portion sizes consumed. After completing the FFQ, the usability survey was administered to adolescents. Statements were read out loud and adolescents were asked to answer verbally whether they strongly agreed, somewhat agreed, neither agreed/disagreed, somewhat disagreed or strongly disagreed with the statements about the photographic food atlas. An A4 size Likert scale diagram identical to the one in the questionnaire was shown to the adolescents to help them indicate their level of agreement. The usability questionnaire was filled in by the interviewer and notes on observations were written down throughout the interview. As well as the Likert scale questions, there were some open-ended questions

to which adolescents answered freely; adolescents were also allowed to make general comments and remarks on the atlas, which were recorded in detail. If adolescents disagreed to some of the statements, they were asked to specify, for example, which foods were missing from the FFQ, or which foods they needed smaller or larger portion sizes of.

Professionals

The research team arranged individual meetings with the Kenyan professionals working in the field of nutrition. Professionals were given either a blueprint of the first draft or the actual first draft of the photographic food atlas to inspect. The purpose of the photographic food atlas, i.e. to be used as a tool in dietary intake research was explained, and they were allowed to look through the atlas at their own pace. Professionals were asked for comments and feedback on the atlas, the feedback was given verbally and was noted down in detail independently by two interviewers. After professionals had given verbal feedback, they were asked to fill in a questionnaire and indicate whether they strongly agreed, somewhat agreed, neither agreed/disagreed, somewhat disagreed or strongly disagreed with the statements about the photographic food atlas, in the presence of the interviewers.

4.7 Data analysis

The background data collected was analysed to see how well different ages, genders and socioeconomic backgrounds were represented in the study. The weighed portion size data was used to calculate three portion sizes (A, B, C) as described above. The results from the Usability Survey Questionnaire were used to calculate an adjusted Usability Score.

The SUS Usability Score formula had been developed specifically for SUS (75). It is calculated so that the points given to negatively worded questions are subtracted from five and the points of positively worded questions have one point subtracted from them, hence all questions can get a value from 0 to 4. The points are added up and multiplied by 2.5 to achieve a score out of 100, though it is important to note this is not a percentage. A score of 68 points is considered an average SUS score, if the score is above this, the product is considered “OK” and if it is below it, the product is considered to have some problems and it “Needs improving”. If the score is 80.3 or above, the product is considered “Good”. A score of below 51 is considered “Bad”.

This exact formula is not applicable to the questionnaire used in this study because our questionnaire had nine questions instead of 10 and all questions were positively worded. However, the Usability Score formula was altered to suit the purpose of this study to give a crude measure of usability (Table 2). This meant that all answer scores had one point subtracted from them and the question scores were

multiplied by 2.7778 instead of 2.5 to achieve a score out of 100. This gave an overall Usability Score per participant for which the same cut-off values, 80.3, 68 and 51, are applicable.

As well as calculating the Usability Score of each participant, the answers to each individual statement in the Likert scale were presented and analysed. Observations and verbal feedback from both adolescents and the nutrition professionals collected during the Usability Survey were recorded and analysed in detail to verify the results of the quantitative Usability Questionnaire as well as to highlight any issues it may have missed.

Table 2. Comparison of formulae for Usability Scores between the original SUS and the adjusted version used in this study.

	Original SUS Questionnaire (75)	Usability Questionnaire for this study (Appendix 8 and 9)
Number of questions	10 questions	9 questions
Format of questions and points given	Positively worded questions 1, 3, 5, 7, 9, e.g. "I thought the system was easy to use" - subtract 1 point Negatively worded questions 2, 4, 6, 8, 10, e.g. "I found the system unnecessarily complex" - subtract points from 5	All questions positively worded - subtract 1 point
Point range per question after adjustment	0-4	0-4
Maximum number of points	4 x 10 = 40	4 x 9 = 36
Multiplication factor to achieve a score out of 100	2.5 (100 ÷ 40 = 2.5)	2.7778 (100 ÷ 36 ≈ 2.7778)
Cut-off values	Good: ≥80.3 OK: <80.3, ≥68 Needs improving: <68, >51 Bad: ≤51	Good: ≥80.3 OK: <80.3, ≥68 Needs improving: <68, >51 Bad: ≤51
Average points required from each question to achieve each cut-off value	Good: ≥3.212 OK: <3.212, ≥2.72 Needs improving: <2,72, >2.04 Bad: ≤2.04 E.g. 80.3 ÷ 2.5 ÷ 10 = 3.212	Good: ≥3.212 OK: <3.212, ≥2.72 Needs improving: <2,72, >2.04 Bad: ≤2.04 E.g. 80.3 ÷ 2.7778 ÷ 9 ≈ 3.212

4.8 Ethical and security considerations

Ethical approval was applied for from Kenyatta University's Ethics Review Committee as part of the ethical proposal for the larger KENFIN-EDURA research project, that the photographic food atlas will be used for. Permission was acquired from the head of the Nutrition Section of the Nairobi City County government to conduct the research in Embakasi Central and Langata sub-counties of Nairobi City. After obtaining permission from Nairobi City County, contact was made with the local health centres and the community nutritionists and community chiefs to plan the research in the local communities. Through the local health centres, the team were provided with a local CHV well acquainted with the community and were accompanied by the CHV at all times in the field. The CHVs also made initial contact with participants for the studies.

The forms with personal details from the participants were kept in a secure place and participants were given participant codes. When the data was recorded digitally, only participant codes were used to ensure the participants' anonymity. The forms with the personal details will be stored until the Masters' thesis is complete, after which they will be disposed of in a safe manner. Informed verbal, or written consent was obtained from the guardians of the adolescents and it was made clear that participation was entirely voluntary and did not have any consequences for the participants. The research in itself was not invasive, but every possible precaution was taken to respect the participants and make them feel at ease.

Participants were given a small remuneration in the form of rice (2kg) and cooking oil (1 litre) at the end of each visit in both the first and third phase for the time they contributed and their participation. However, participants were not aware of the remuneration, until it was given at the end of the visit, as it was important that the participants did not feel under any pressure to participate. This was also done to minimise conflicts within the community of who should get to participate and to avoid selection of certain types of families.

5 Results

5.1 Characteristics of participants

Household survey

Twenty-one adolescents participated in portion size weighing sessions (Table 1). Two adolescents were turned away due to young age and two families declined to participate (Figure 1). One child was ill and the visit was postponed. Ten of the adolescents were from Embakasi and eleven from Langata. The age of the participants was rounded up or down to the closest full year. The participants comprising nine girls and twelve boys were between 9-14 years, the average age being 12 years. Their school class level varied from three to eight, the median being six.

Table 3. Basic characteristics of the adolescents who participated in the weighing of food portions.

Characteristic	Embakasi Central (n=10)	Langata (n=11)	Total (n=21)
Age, average in years (range)	12 (9-14)	12 (9-14)	12 (9-14)
Sex			
Female, n	4	5	9
Male, n	6	6	12
Number of siblings, n (range)	3 (0-5)	2 (1-4)	2 (0-5)
Primary school education, class level (range)	6 (3-8)	6 (4-8)	6 (3-8)

The education level of ten mothers and one grandmother (acting as guardian) in Embakasi and seven mothers in Langata was obtained (Figure 3). In Embakasi, 60% (6) of the mothers reported primary school as their highest level of education, 30% said they had achieved secondary education and the one grandmother had not obtained any education. In Langata, over 63% (5) of the mothers reported achieving university education, 25% college and one mother reported no education obtained. It was not possible to obtain data on the mothers' education in three cases in Langata due to the mother having passed away, or the mother not being present for the entire duration of the interview and the adolescent not being able to recall the level of education.

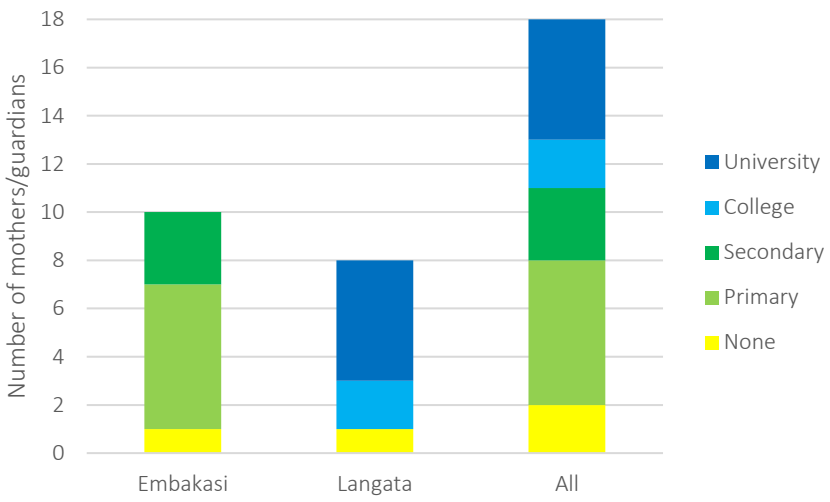

Figure 3. Adolescents' mothers'/guardian's highest level of education.

The education level of three fathers in Embakasi and eight fathers in Langata was obtained (Figure 4). In Embakasi, two fathers had achieved secondary education and one primary education. The missing data on fathers' education in the other seven cases was due to the fact that women were single parents. In Langata, 75% (6) of the fathers had achieved university level education, one had obtained college and one primary level. In Langata, the missing data for three of the cases was due to the father not being present for the entire duration of the interview and the adolescent could not recall their level of education.

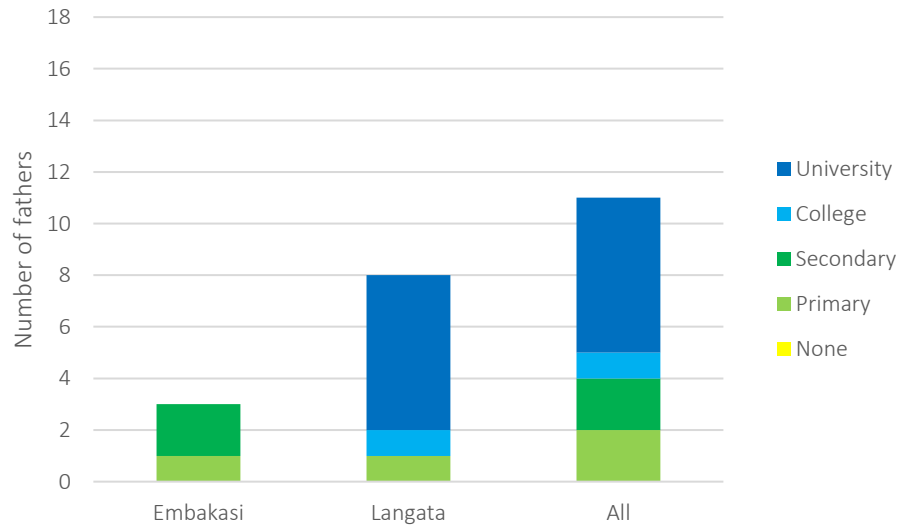

Figure 4. Adolescents' fathers' highest level of education.

The occupation type of all seventeen mothers and one grandmother (acting as guardian) was obtained (Figure 5). In Embakasi, housewife and casual labourer were the most common occupations, both at 30%. Twenty percent ran a small (informal) business and one reported having a salaried job. The

grandmother acting as guardian for one adolescent reported unemployment. In Langata, 50% (4) of mothers had a salaried job, three ran businesses and one mother was a housewife.

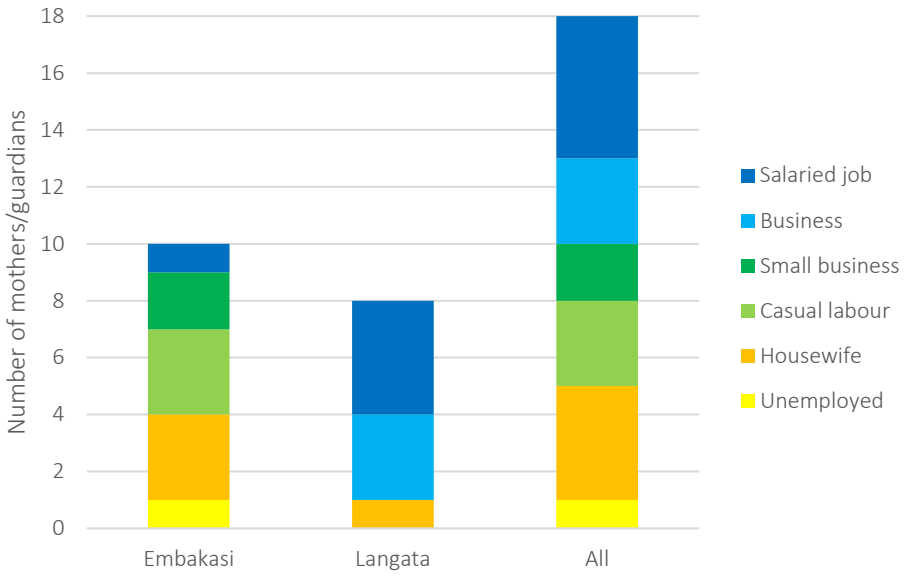

Figure 5. Adolescents' mothers'/guardian's occupation.

The occupation type of twelve fathers was obtained (Figure 6). In Embakasi, one father was unemployed, one a casual labourer and one ran a small business. In Langata, 50% (4) of the fathers ran their own business, three had salaried jobs and one father was a religious leader.

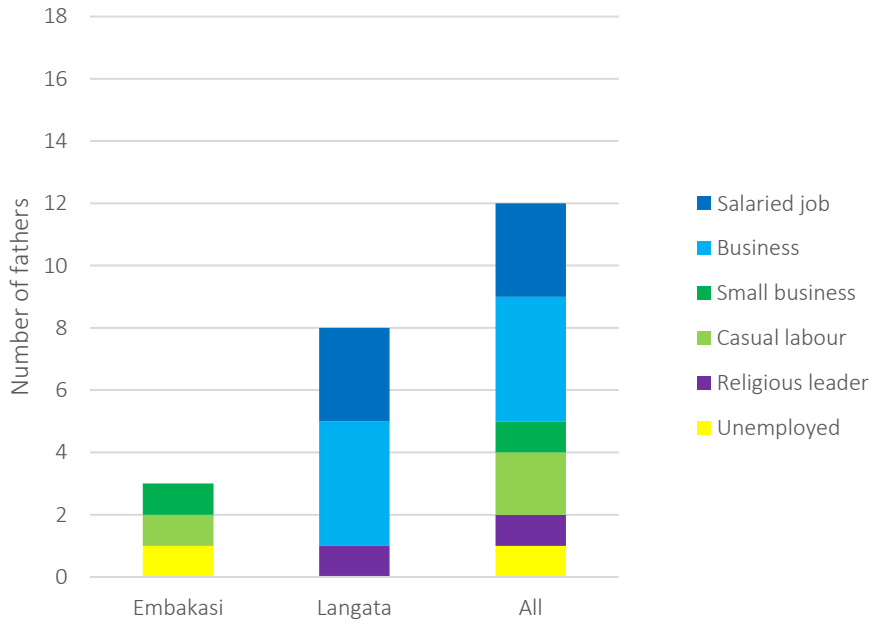

Figure 6. Adolescents' fathers'/guardian's occupation.

Usability survey

Five adolescents from Embakasi and three adolescents from Langata participated in the usability survey (Table 4). No adolescent refused to participate. The ages of the participants ranged between 9-14 years (rounded to the closest full year), the mean being 12 years. Their primary school education level ranged from class four to eight. The participants consisted of seven girls and one boy.

Table 4. Basic characteristics of the adolescents who participated in the usability survey.

Characteristic	Embakasi Central (n=5)	Langata (n=3)	Total (n=8)
Age, average in years (range)	11 (9-13)	13 (11-14)	12 (9-14)
Sex			
Female, n	4	3	7
Male, n	1	-	1
Number of siblings, n (range)	3 (0-7)	2 (2)	(0-7)
Primary school education, class level (range)	5 (3-7)	7 (4-8)	(4-8)

Education level data was obtained for all five mothers and three fathers in Embakasi and one mother and one father in Langata (Figure 7 and 8). Two women were single parents in Embakasi and one in Langata, hence data on three fathers was not available. In two cases in Langata, parents were not present for the entire duration of the interview and their children could not recall their education level. In Embakasi, the most common levels of education achieved among both mothers and fathers were either primary or secondary. In Langata, both mothers and fathers had achieved college education.

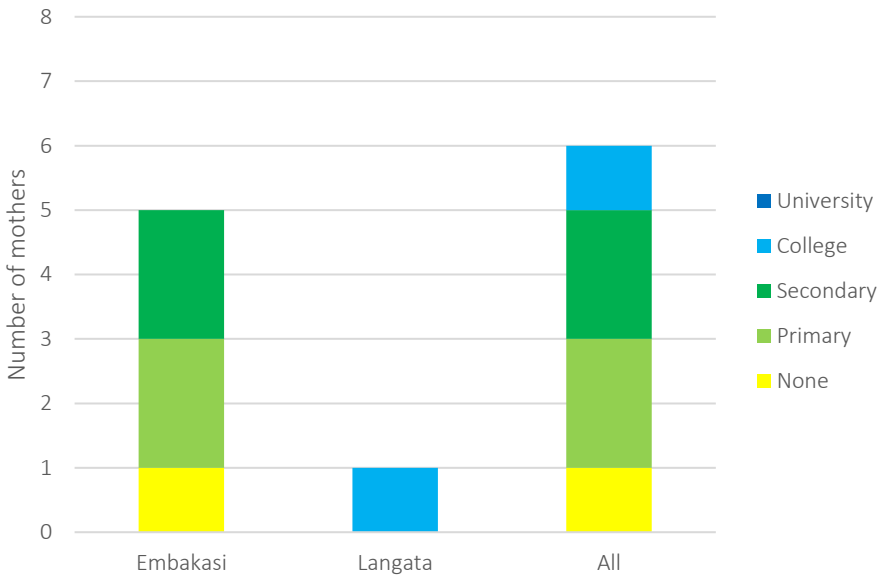

Figure 7. Adolescents' mothers' highest level of education

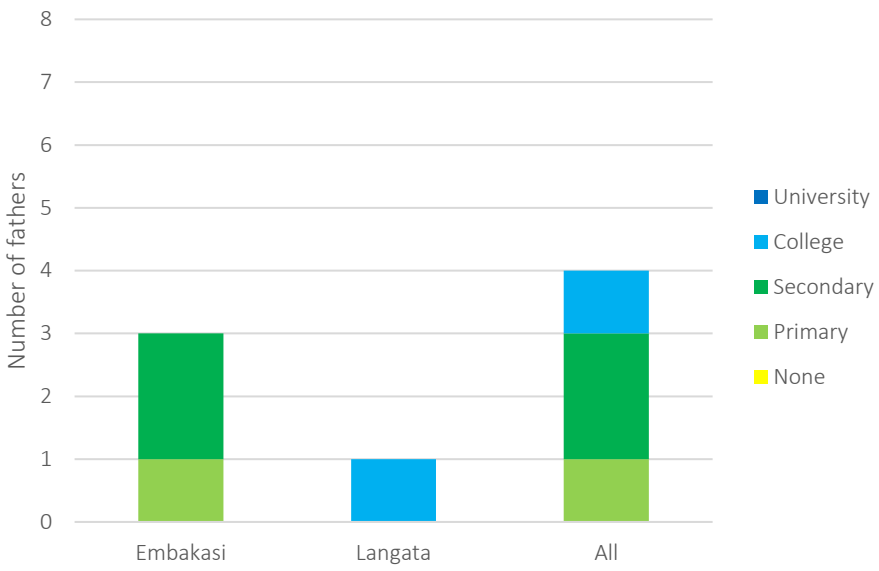

Figure 8. Adolescents' fathers' highest level of education.

The occupation situation of all five mothers in Embakasi and all three mothers in Langata was obtained (Figure 9), as well as all fathers (three in Embakasi and two in Langata) (Figure 10). In Embakasi, small business, casual labour and unemployment were the occupations recorded amongst both mothers and fathers, whereas in Langata a salaried job, business and housewife were reported as occupations.

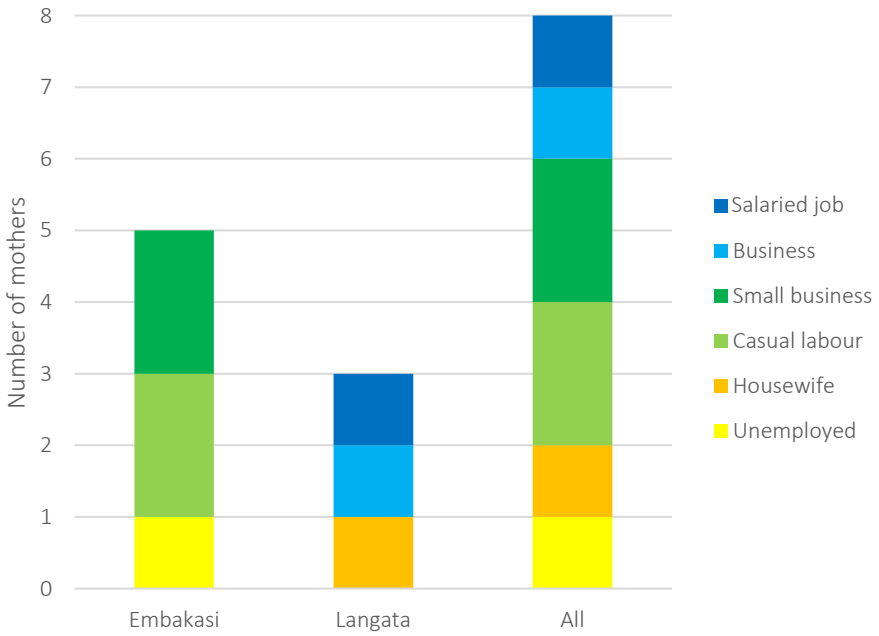

Figure 9. Adolescents' mothers' occupation.

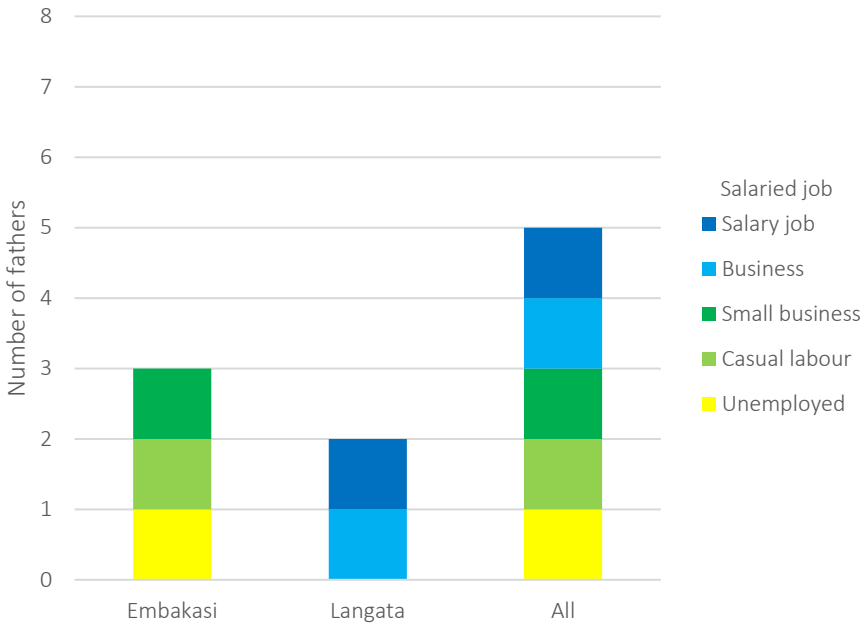

Figure 10. Adolescents' fathers' occupation.

5.2 Most commonly eaten foods and portion sizes

The number of weights recorded per food ranged from 0-9 (Table 5). These included weights from the household survey and cooking demonstrations in both Embakasi and Langata. The most commonly eaten amorphous foods in the household surveys were rice and various mixtures of rice with, carrots/pumpkin, *Irish potato* or beans, maize *ugali*, kales (*Sukuma wiki*) and bean stew. Often rice and *Sukuma wiki* were prepared with tomatoes and onions. The most common drink was tea (*chai*: boiled water and milk strained through tea leaves). The ratio of milk to water varied from 1:1 to around 1:8. Other commonly consumed or mentioned amorphous foods were cabbage, local traditional vegetables, green grams, *uji*, fish (tilapia & *omena*), various stews (beef, vegetable, goat etc.), *githeri*, fries, *mukimo*, and *matumbo* (offal). In Langata, there was a wider variety of foods eaten. For example, the following amorphous foods were mentioned, breakfast cereals, noodles, spaghetti, various spreads (peanut butter, jam, ham), *kachumbari* (tomato and onion salad mix) and minced meat.

Table 5. Portion sizes of amorphous foods derived from household and market surveys and cooking demonstrations in Embakasi Central and Langata arranged according to number of portions weighed.

Food number in atlas	Food	Number of portions weighed	Portion A (g) (0.5 x B)	Portion B (g) (Mean)	Portion C (g) (1.5 x B)	Weighed portion size range		
						Minimum (g)	Maximum (g)	SD (g)
	Tea[1] (actual)	9	151	302	453	219	434	70
2	Rice[1,3]	5	102	204	306	119	284	71
5	Beans[1,3,6]	4	64	127	191	74	194	55
1	Ugali[1]	4	190	380	570	273	515	125
46	Beef stew[2]	3	56	111	167	75	149	37
20	Cabbage[1,2]	3	59	117	176	76	161	43
16	Chips (homemade) [3, 7]	3	61	121	182	107	129	12
79	Kachumbari[1,3]	3	41	82	123	43	109	35
21	Kales and spinach / Sukuma Wiki[1]	3	70	140	210	81	192	56
22	Traditional vegetables[2]	3	102	204	306	116	274	80
23	Broccoli, cauliflower, carrots[3]	2	38	76	114	NA	NA	NA
50	Chicken stew[3, 6]	2	48	96	144	33	159	89
77	Githeri[2,3]	2	100	200	300	174	226	27
49	Goat stew[3, 7]	2	71	142	213	113	170	40
26	Green grams[3]	2	69	138	207	110	165	39
48	Minced meat[3, 7]	2	74	147	221	131	162	22
82	Mukimo[2]	2	204	407	611	310	504	137
56	Omena[2]	2	53	105	158	75	135	42
78	Pilau[3]	2	81	162	243	147	177	21
80	Rice and beans[1]	2	286	572	858	512	631	84
81	Rice, potato & carrot/pumpkin[1, 6]	2	176	351	527	317	385	48
57	Tilapia stew[2, 7]	2	92	183	275	141	224	59
9	Cornflakes[3]	1	21	42	63	42	42	0
63	Fat spread[3]	1	2	4	6	4	4	0
58	Fish fillet (Nile perch) [2]	1	31	62	93	62	62	0
43	Grapes[1, 7]	1	68	135	203	135	135	0
11	Muesli[3]	1	25	50	75	50	50	0
55	Offal[3]	1	50	100	150	100	100	0
68	Popcorn[3]	1	25	50	75	50	50	0
7	Spaghetti[3, 7]	1	105	209	314	209	209	0
64	Jam/honey[1]	0	4	8	12	NA	NA	NA
65	Peanut butter/Nutella[1]	0	5	10	15	NA	NA	NA

SD=Standard deviation, [1]Weights from household survey; [2]Weights from cooking demonstration in Embakasi; [3]Weights from cooking demonstration in Langata; [6]Wrong weight in atlas (see Appendix 11); [7]Figures rounded slightly differently and thus differ from those in the atlas (see Appendix 10 and Appendix 11).

The most commonly consumed foods served in units or pieces were bread, fruits, baked products and tubers (Table 6). Bananas and oranges were the most commonly eaten fruits, but other fruits mentioned included mango, avocado, pineapple and watermelon. Pastries and tubers served in pieces/units included *samosas* (deep-fried pastries filled with vegetables or meat), *mandazis/KDF* (type of doughnut), *chapatis*, pancakes, eggs, boiled/roasted maize and various tubers (sweet potato, arrowroot, pumpkin). In Langata, there was a wider variety of foods served in distinct units such as hotdogs, pizzas, deep-fried chicken, more fruits (kiwi, apple, grapes, peaches), bacon, sausages, *nyama choma* (grilled meat), as well as sweets, cakes and crisps. In Embakasi, some local market foods were sold in pieces, such as chicken feet and meat off a cow's head.

Table 6. Portion sizes and weights of foods served in units derived from household and market surveys and cooking demonstrations in Embakasi and Langata arranged according to order in the atlas (food number).

Food number	Food	No of weighings/unit	Portion A	Portion B (Mean)	Portion C
Cereals and grain products					
3	Chapati (homemade), piece			1	
	g[2]	3		106	
4	Pancake (homemade), piece			1	
	g[2]	3		118	
5	Uji porridge, full mugs[1]		Thermos mug	Plastic mug	Ceramic mug
	g[2]	1	330	328	347
6	Bread, slice[1]	4	1	2	4
	g[3]	6	26	52	104
8	Noodles, 1 packet (120g) [3]			1	
	g[3]	1		219	
10	Weetabix, piece[1,3]		1	2	3
	g[3]	1	20	40	60
12	Mandazi (market, triangle), unit[1]		0.5	1	1.5
	g[4,5]	5	22	44	66
13	KDF (market) [1]		0,5	1	1,5
	g[5]	4	46	92	138
Tubers					
14	Sweet potato (market), whole[4]			1	
	g[4]	1		323	
15	Sweet potato small (home cooked) [2]		0.25	0.5	1
	g[2]	1	48	96	192
17	Chips, market serving[4]			1	
	g[4]	2		80	
18	Bhajia, market serving[3,5]		0.25	0.5	1
	g[5]	1	126	257	383
Vegetables					
19	Pumpkin, piece[2]		Different sized pieces		
	g[2]	1	88	103	151
24	Boiled maize, piece		Different sized pieces		
	g[4]	1	174	223	281
Fruits					
27	Banana (with skin) (different sizes)		Different sized units		
	g[5]	3	50	76	158
28	Large banana without skin, unit[3]		0.5	1	1.5
	g[5]	3	42	83	135

Food number	Food	No of weighings/unit	Portion A	Portion B (Mean)	Portion C
29	Small sweet bananas without skin, unit[3]		2	4	6
	g[5]	3	60	120	180
30	Orange local (different sizes)		Different sized units		
	g[4]	1	173	239	301
31	Orange sweet South Africa, unit[1]		0.5	1	1.5
	g[5]	3	73	145	218
32	Orange from supermarket with skin, unit[1]		0,5	1,0	1,5
	g[5]	3	96	191	287
	Tangerine (different sizes)[5]		Different sized units		
	g[5]	1	82	129	168
33	Apple (different sizes)		Different sized units		
	g[5]	1	105	125	190
34	Apple (medium), unit[1]		0.5	1	1.5
	g[5]	1	63	125	188
35	Mango (different sizes)		Different sized units		
	g[5]	1	264	283	411
36	Mango (local), unit/whole			1	
	g[4]	2		225	
37	Mango without stone (large) [1]		0.25	0.5	1
	g[5]	1	93	185	370
38	Pineapple, slice[1]		1	2	3
	g[5]	6	80	160	240
39	Watermelon, slice[2]			1	
	g[4]	1		246	
40	Avocado (different sizes)		Different sized units		
	g[4,5]	1	170	366	467
41	Avocado medium (without stone), unit[1]		0.25	0.5	1
	g[4,5]	1	76	153	305
42	Avocado small (without stone), unit[1]		0.25	0.5	1
	g[4,5]	2	37	74	148
44	Kiwi, unit[1]		0.5	1	1.5
	g[5]	5	42	83	125
45	Peach, unit[1]		0.5	1	1.5
	g[5]	4	82	164	246
Meat, fish & eggs					
47	Beef head (different sized pieces)		Different sized pieces		
	g[4]	1	35	41	74
51	Hot dog sausage/frankfurter, unit[3]		1	2	3
	g[5]	3	49	98	147
52	Sausage, unit[3]		1	2	3
	g[5]	3	41	82	123
53	Bacon, piece[3]		1	2	3
	g[5]	3	8	16	24
54	Ham, slice[3]			1	
	g[5]	1		25	
59	Scrambled egg, no. of eggs[1,3]		1	2	3
	g[5]	1	89	178	266
60	Fried egg, no. of eggs[3]		1	2	3
	g[5]	1	50	100	150
61	Boiled egg[3]		1 egg	yolk	white
	g[5]	4	56	21	35
Dairy products					
62	Yoghurt		Different unit sizes		
	ml[5]	1	150	250	450

Food number	Food	No of weighings/unit	Portion A	Portion B (Mean)	Portion C
Spreads and sauces					
66	Ketchup, sachet		1	2	3
	g[5]	1	10	20	30
Sweets and snacks					
67	Crisps, packet sizes		small pkt	0.5 x large pkt	large pkt
	g[5]	1	30	75	150
69	Lollipop[3]		1	2	
	g[5]	2	22	44	
70	Queen cake[3]		1	2	3
	g[5]	3	53	106	159
71	Biscuit, units[3]		5 (small pkt)	10	15
	g[3]	5	21	42	63
Beverages					
72	Tea (ceramic mug)		0.5	1	
	g[3]	1	198	327	
73	Tea (cream mug)		0.5	1	
	g[3]	1	166	321	
74	Fermented milk (glass)		0.5	1	
	g[3]	1	152	304	
75	Juice (ceramic mug)		0.25	0.5	1
	g[3]	1	105	200	341
76	Juice (plastic cup)		0.25	0.5	1
	g[3]	1	77	165	243
Composite dishes					
83	Samosa (A=green grams, B=potato), unit		1	1	
	g[4]	2	25	33	
84	Sandwich, unit[3]		1	2	
	g[3]	2	73	146	
85	Hotdog, unit			1	
	g[5]	1		109	
86	Beef burger (with cheese), unit			1	
	g[5]	1		197	
87	Pizza (medium), slice		1	3	6
	g[5]	6	70	210	420
88	Pizza (large), slice		1	4	8
	g[5]	8	90	360	720

[1]Weights from household survey, [2]Weights from cooking demonstration in Embakasi, [3]Weights from cooking demonstration in Langata, [4]Weights based on market portions in Embakasi, [5]Weights based on market portions in Langata

5.3 Adolescents' usability survey

Three adolescents from Langata and five adolescents from Embakasi completed the usability survey. The overall usability score for the photographic food atlas was calculated for each participant. The average score was 77.4 ±9.2 which falls in the category of OK (Table 7). The lowest score was 66.7 (Needs improving) and the highest 94.5 (Good). Three (38%) participants obtained an overall score classified as Good and OK, with two obtaining an overall usability score classified as Needs improving.

Table 7. Adolescents' overall Usability Score.

	Usability Score (n=8)
Mean ± standard deviation	77.4 ±9.2
Min; max	66.7; 94.5
Distribution of scores	
Good (≥80.3)	3
OK (80.3, ≥68)	3
Needs improving (<68, >51)	2
Bad (≤51)	-

The highest rate of agreement amongst adolescents (88% strongly agreed) was found for the statement that the food atlas aided the filling in of the FFQ (Figure 11, Q2). More than half of the adolescents also strongly agreed (63-75%) that the food atlas was easy to use (Q4), the pictures were big enough (Q6) and that they could recognise all the foods and drinks presented in the pictures (Q9). Only one adolescent each strongly disagreed to Q9 and Q6.

Half of the adolescents strongly agreed that the food atlas helped them to remember portion sizes (Q3), that there were large enough portion sizes in the book (Q8) and that they could tell the difference between the portion sizes (Q10). However, one adolescent strongly disagreed and one neither agreed nor disagreed on Q8. When asked if the portion sizes were small enough (Q7), three strongly agreed (38%) whereas two disagreed and two could not say. Finally, the claim with the least strong agreement and most disagreement (38% strongly disagreed) was whether the adolescents could use the food atlas by themselves (Q5).

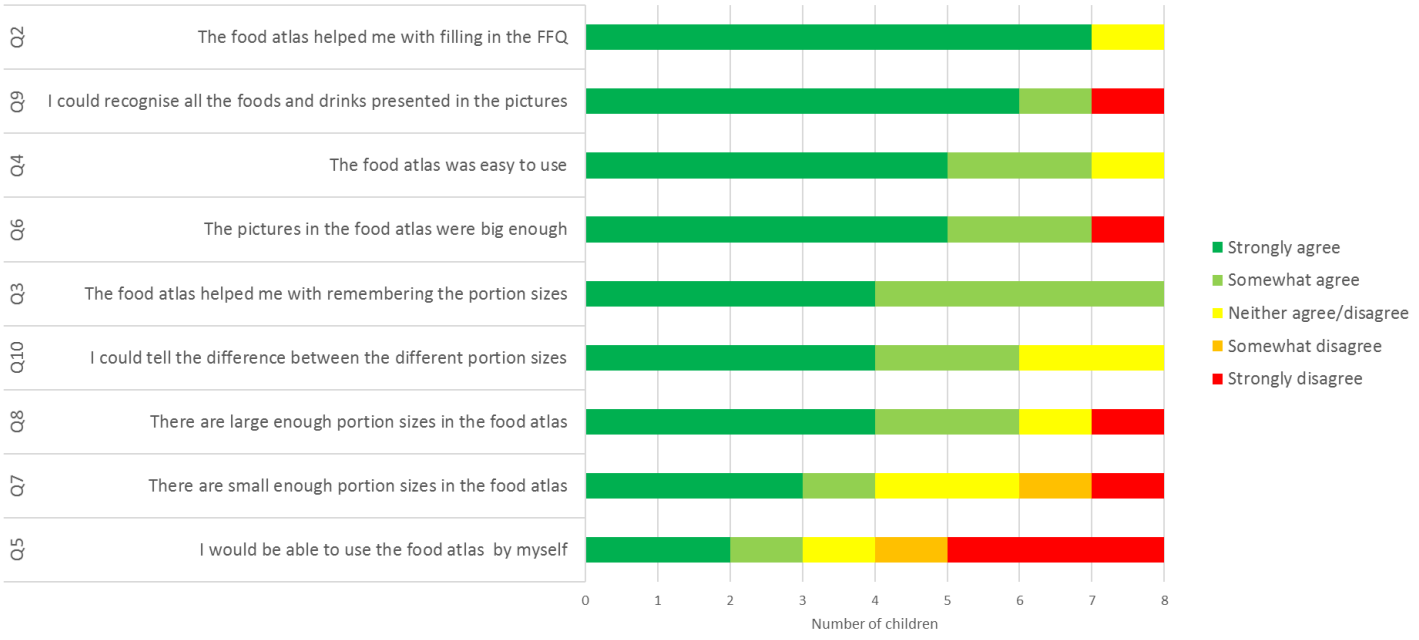

Figure 11. Adolescents' answers to the usability survey arranged according to strong agreement.

One adolescent out of eight said that there were foods they normally ate that were missing from the FFQ. These were indigenous foods, such as *kamongo* (mudfish), *nzo* (*mbaazi* in Kiswahili and dry green pigeon peas in English), *mu* (indigenous fruit), *tomoko* (custard apple), *mawele* (finger millet). Adolescents mentioned that they needed smaller portion sizes in the following foods: *githeri*, *kachumbari*, *matumbo*, beef, beans, boiled maize, pumpkin, chips and *ugali*. One adolescent reported needing a larger portion size for *kachumbari*. Adolescents reported *pilau* and minced meat as difficult to recognise.

Seven adolescents said they liked using the photographic food atlas and no answer was recorded for the eighth adolescent. Adolescents were asked some open-end questions on how they found using the food atlas. Most adolescents stated they liked looking at the different pictures of foods and many comments recognised the educational value of the atlas. To illustrate these sentiments, some comments from the adolescents are included below:

> *"It challenges me to work on my diet."*
> Stated by a female participant in Langata.

> *"I can see the different foods and amounts and can decide what food to eat."*
> Stated by a female participant in Langata.

> *"I can look at the foods to know their names."*
> Stated by a female participant in Embakasi.

> *"I can look at the pictures, can read it and can draw the foods."*
> Stated by a male participant in Embakasi.

5.4 Professionals' usability survey

Four professionals completed a usability survey. All professionals were from a university institution working in the field of nutrition. Two said they had been in the profession for 10 years, one for 9 years and for one no information was recorded. One specified that they were a clinical nutritionist, whereas another two were focused on community nutrition.

The overall usability score for the photographic food atlas was calculated for each participant. The average score was 81.9 ±14.8 which falls in the category of Good (Table 8). The lowest score was 66.7 (Needs improving) and the highest 97.2 (Good). Two (50%) participants obtained an overall score classified as Good and the two others got scores classified as OK and Needs improving.

Table 8. Nutrition professionals' overall Usability Score.

	Usability Score (n=3)
Mean ± standard deviation	81.9 ±14.8
Min; max	66.7; 97.2
Distribution of scores	
Good (≥80.3)	2
OK (80.3, ≥68)	1
Needs improving (<68, >51)	1
Bad (≤51)	-

The strongest agreements among professionals were for the statements that the portion sizes were small enough (Figure 12, Q5) and that the most commonly consumed foods by Kenyan adolescents were included in the food atlas (Q9). Half strongly agreed that they would use the atlas in their own research or counselling (Q11), portion sizes seemed reasonable (Q3), there were enough portion sizes for each food (Q4) and that pictures in the atlas were big enough (Q7). However, one professional somewhat disagreed and one neither agreed nor disagreed when asked if the pictures in the atlas were big enough. This was the only statement where there was any disagreement. Finally, the following statements received the least answers of strong agreement (albeit no disagreement): there are large enough portion sizes (Q6), I could recognise all the foods and drinks (Q8) and the order in which foods were presented were logical (Q10).

In the open spaces of the survey form, two professionals wrote that the quality of pictures needs to be improved and that they need to be made larger and clearer. One professional noted that more portion sizes are needed for *chapati*, pumpkin, boiled maize and sweet potato for instance. When asked why, or why not, they would use the food atlas in their research/counselling, one professional (a clinical nutritionist), noted that for their work they would require more data on the nutrient content of food to be able to quantify nutrient intake.

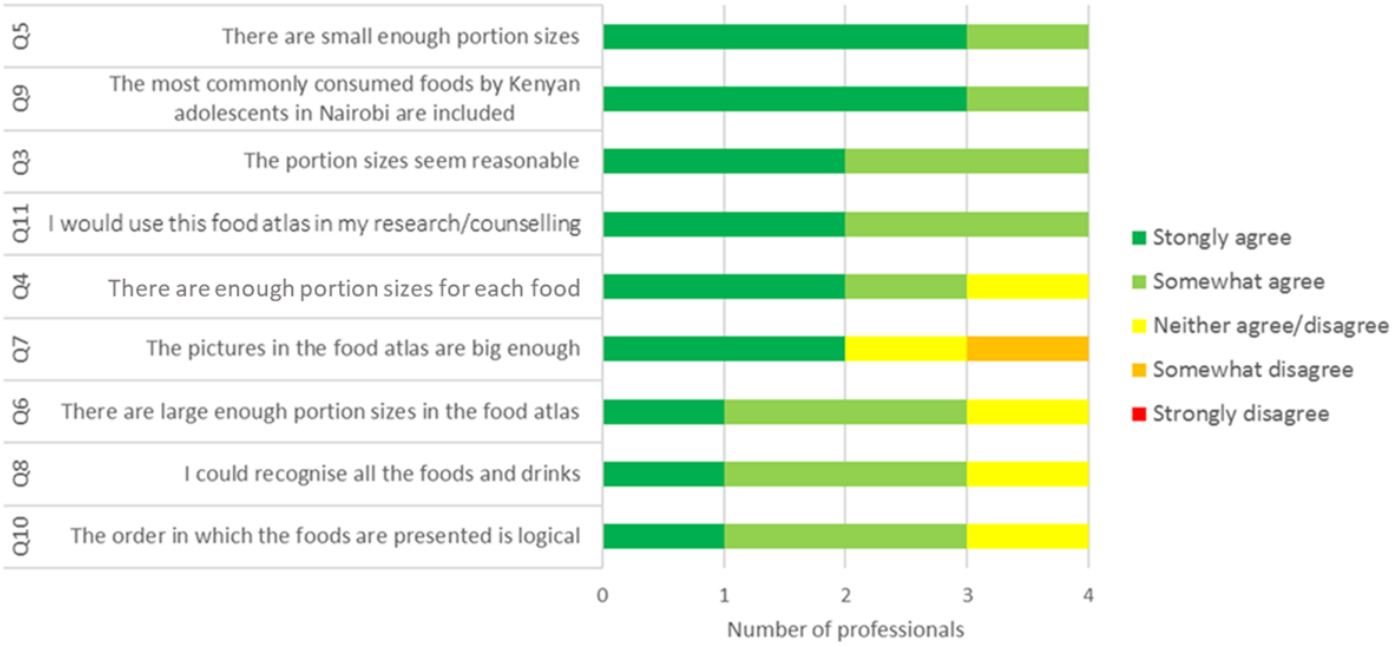

Figure 12. Professionals' answers to the usability survey arranged according to strong agreement.

Professionals also gave a lot of verbal feedback, which was recorded in detail. The verbal feedback is summarised below as well as the actions taken when forming the second photographic food atlas and the rationale behind the choices made (Table 9).

Layout and photography

> *"The pictures aren't big enough or clear enough. I can't differentiate between the portions."*
>
> Stated by a nutrition lecturer specialised in community nutrition.

Many of the professionals reported that the pictures were too small, dark and grainy. The pictures of different meats and fish were reported to be particularly unclear. Also, the varying angle and distance the pictures were taken at was deemed to be confusing. A contrasting background or plate were recommended to aid portion size identification, especially of light-coloured food such as *ugali* and rice. It was suggested that the weights of portions should be close to (underneath) the corresponding pictures for easy use and to avoid confusion. Another suggestion for ease of use was that different food groups should be colour-coded so that people using the book in the field can easily flick through it and find the pages needed. It was recommended that the order of foods be reviewed to coincide with the Food and Agriculture Organisation of the United Nation's (FAO) categorisation of foods.

Variety of foods

> *"You need more variety of biscuits, mandazis, breads, candies."*
>
> Stated by a nutrition lecturer specialising in clinical nutrition.

A larger variety of foods were suggested, for example for root tubers, meat and meat products (sausages, kebab), fish and fish products (fish balls), bread, sandwiches, groundnuts, sesame seeds and other vegetables. Some of the vegetables and legumes/pulses recommended to be included were carrots, green pepper, eggplant, courgette, cucumber, French beans, green peas, cowpeas, lentils and "Western ndengu". Some commonly used root tubers in Kenya were mentioned to be missing such as arrowroot and cassava. A larger variety of sweets/candies, cakes, biscuits and carbonated and sugary drinks was also suggested to be added. Local spreads used such as avocado and banana were noted to be missing. Certain foods typical to the slum settings were also recommended to be included, for example chicken feet.

Portion sizes

> *"There are different types and shapes of mandazis. And you need to change the portion size of pineapple and watermelon to look like the ones sold on the street markets."*
>
> Stated by a nutrition lecturer.

Some felt that there were portion sizes and shapes lacking for some of the tubers, fruits and maize. The professionals mentioned it would be important to have a variety of the different shapes of, for example, pumpkin, maize, pineapple and watermelon pieces, rather than different portion sizes. Many commented on the fruit portion sizes, there was confusion as there were multiple varieties of the same fruit, different individual sizes of the same fruit and also different portion sizes of the same fruit (e.g. one quarter, half or whole fruit). The professionals said it would be easiest if individual fruits of different sizes were presented and that there would be an assortment of the different sizes and varieties (local, imported, sweet) of fruits. It was recommended that the portion sizes of fish should be represented to the typical Kenyan serving sizes, head, middle and tail. However, professionals commented that because the foods weren't presented in identical portion sizes, it was hard to distinguish between the portion sizes of certain foods like *mukimo* and *githeri* often served in mounds. A specific comment on traditional vegetables was to have smaller portion sizes for each traditional vegetable separately, as not all combine them in cooking.

Details on foods and preparation methods/weighing methods

> *"You need to include food preparation methods. For example in Mombasa and Nyanza they use a lot more oil, sugar, spice and frying."*
>
> Stated by a nutrition lecturer specialising in clinical nutrition.

An often-mentioned comment was to include details of the cooking method/food preparation method in the name of foods, for example whether something was boiled, fried, deep-fried or oven-baked. It was noted that it would be good to weigh fruits without peels or the stone and fish without bones and to also indicate this in the name. More information was also required on some of the foods, for example for yoghurt whether it is flavoured, natural or fruit-based and the thickness. It was also noted that for some foods it maybe of importance to include other measurements as well as weight, for example, for pancakes and chapattis the thickness and diameter.

Comments on further development

> *"A very useful tool, but for counselling, the nutrient data of portions would be useful."*
>
> Stated by a nutrition lecturer specialising in clinical nutrition.

Many hoped pictures of the most common household utensils would be included in the next drafts with their volumes recorded to allow for variation between households using different cup and plate sizes. The majority of the professionals mentioned it would be a huge advantage to have the nutrient contents of the various foods included in the atlas. Another suggestion for future improvement was to include a standard recipe for composite dishes to aid with calculating nutrient content of foods as most dietary intake analysis software will not have these.

Overall remarks

> *"Who and what is this picture booklet aimed for? All of Kenya? Which age group?"*
>
> Stated by a nutrition lecturer specialised in community nutrition.

> *"What purpose is this used for?"*
>
> Stated by a nutrition lecturer specialising in clinical nutrition.

A general recommendation was to outline clearly the scope and purpose of the photographic food atlas and clarify that it is aimed at 9-14-year olds in Nairobi. There were also hopes expressed that the atlas could be diversified to represent larger areas of Kenya too, such as rural areas and the coastal regions. Overall, the consensus was that a photographic food atlas is much needed and would be used in research. Professionals stated there is demand for an adult version of a photographic food atlas.

Table 9. Verbal feedback from nutrition professionals, number of times remark was made, whether action was taken and what action was taken and the rationale behind the choice made.

Remark	No. of times remarked	Result	Action taken	Rationale
Layout and photography				
Adjust food groups and their order; food groups should follow FAO guidelines.	2	Yes	Food groups and their order were rearranged to coincide with FAO classification and order.	
Colour-code different food groups for easy use of the booklet.	1	Yes	Food groups were colour coded.	
Increase visibility of the food photographs. They need to be clear and have a close-up view, especially for vegetables meat and fish. Pictures were too small, dark and also grainy.	4	Yes	New pictures taken to ensure better lighting and positioning of foods. Better formatting of atlas. The number of food items per page were reduced from three per page to four per page to allow for bigger pictures and easier viewing.	
For vegetables, fruits and meats, the portions could be better depicted by the use of match box sizes (typically used in Kenya).	1	No		Portion sizes were based on weighed data. It was decided better not to confuse participants with serving sizes as they are not equivalent to portions of foods consumed.
The portion weights should be under each picture for easy use and to avoid confusion.	2	No		Weights of foods were decided to be kept separate from the pictures so as not to influence users of the Atlas.
Weights for fruits without peels and stones, weights of fish without bones.	2	Yes	Weights for fruits and fish were taken without peels, stones and bones and this was also indicated in the name of the food.	
The angles of the photos varied hence do not depict the true nature.	1	Yes	New pictures taken in standardised conditions; angle kept standard in all pictures.	
Use a contrasting background or plate so that foods and their sizes are easily recognised.	1	No		Some foods were of light colouring (rice, *ugali*), but most foods were colourful and, therefore, a white background and plate were selected and kept the same throughout. Pictures were retaken with better lighting conditions which improved contrast.

Remark	Number of times remarked	Result	Action taken	Rationale
Variety of foods				
Some common local foods missing such as root tubers (arrowroot, cassava), fish (other than tilapia), fish balls, African sausage, smokies, groundnuts, sesame seeds**,** vegetables (carrots, green pepper, eggplant, courgettes, cucumber, French beans, green peas, black beans "njahi", "mbaazi", cow peas, lentils, western ndengu), pork, dairy products (milk, lala, cheese), local spreads (avocado, banana), more rice dishes, fruits, foods typical to the low-income areas (e.g. chicken feet, meat from the head of the cow).	4	Yes	Missing foods were included. Foods such as: arrowroot, cassava, other fish, fish balls, a variety of sausages (incl. smokies and African sausage), groundnuts, sesame products, pork, more dairy products, *githeri*, courgettes, carrots, eggplant, green peas, French beans with other vegetables, lentils, passionfruit, tree tomato, berries etc.	We did not succeed in including more foods from the low-income areas or including all the vegetables recommended due to a lack of resources.
Food portion sizes				
Need to change some of the portions to reflect typical Kenyan portions, e.g. pumpkin, watermelon, pineapple (the way it is cut and sold at the market), fish (typical portions are head, middle section, tail).	2	Yes	Portion sizes were changed to reflect typical Kenyan portions. More portion sizes of pumpkin and watermelon and fish portions were depicted as instructed.	
Certain foods (e.g. *githeri* and *mukimo*) need to be presented in identical shapes to help in distinguishing between the different portion sizes.	2	Yes	Portion sizes of foods served in mounds were shaped as identically as possible between the different portion sizes.	
Fruits are confusing due to there being pictures of different varieties of fruits, different sized fruits and different portion sizes	1	OK		Fruits were a challenging food group as there were many different varieties and individual sizes. In addition, adolescents reported eating quarters and halves of fruits in schools instead of full sizes. We aimed to clarify fruit varieties and make portion sizes more consistent, however in the process some fruits were accidentally lost e.g. sweet banana of larger size.
Food items such as pancakes, *chapati*, *mandazi*, cakes, there is need to think about sizes and maybe measure the thickness and diameter	1	No		Measures of thickness, diameter or size in general were not included as it was felt that it would not improve weight estimations and would only add an extra burden on the participant. Instead a variety of different types of *chapati*, pancakes, *mandazis* and cakes were included.
Include pictures & details on cooking equipment and utensils used for serving. Use of standard millilitres for liquids/beverages is important.	3	Yes	Pictures and volumes of different cups, plates and spoons typically found in Kenyan households was included in the beginning of the Atlas.	

Remark	Number of times remarked	Result	Action taken	Rationale
Details on foods				
Include footnotes on foods	1	No		The layout of the Atlas was aimed to keep it as simple as possible, with as little extra information as possible. All necessary information on foods was included in the name.
Include details on preparation/cooking methods, what oils used etc.	3	Yes	Food preparation methods were added to the name where applicable.	
Give details on food e.g. yoghurt: flavoured, natural, fruit-based, drinkable, thick; fruits (local, imported, sweet).	3	Yes	Details of the foods were included in the names of the foods (and more types of yoghurts included).	
Clarify the specific portion of offal: does it mean the “villi”-rich part or the “tube”.	1	No		It was not deemed necessary to include a distinction between the two different parts.
Need to find a suitable name for foods in the low-income settings e.g. meat from the cow’s head.	1	No		We did not succeed in including more foods from the low-income areas due to a lack of resources.
The cereals should be displayed without milk to avoid confusion.	1	Yes	In the new pictures, cereals were photographed without milk.	
Represent each vegetable on its own, not mixed.	1	OK	Some vegetables were pictured alone such as tomato, carrots, courgette, eggplant and cucumber.	It was not possible to photograph all vegetables alone due to limited resources and not all were thought to be necessary to be photographed separately, for example traditional vegetables which can often be mixed.
Bacon needs to be shown raw for easy identification.	1	No		It was not deemed necessary to include a picture of raw bacon as well as cooked bacon. Retaking the pictures will help to clarify the picture of bacon.
Standard recipes and nutrient content				
Standard recipes for composite dishes; a clarification of the proportion of the different ingredients.	2	No		As the purpose of this atlas is to aid in portion size quantification, details of the components and nutrient contents were not deemed relevant for the purpose of the atlas. Recipes used were based on the ones used by the adolescents’ mothers. We recommend using the official Kenyan Food Recipes (2018) publication.
Nutrient composition of food items needed as the Kenyan database only includes uncooked food items. Especially for composite dishes and foods like *githeri* and *mukimo*.	3	No		As the purpose of this atlas is to aid in portion size quantification; details on the components and nutrient contents were not deemed relevant for the purpose. We recommend using the official Kenyan Food Recipes (2018) publication.
Need to establish codes of foods, especially for analysis.	1	OK		Foods were given a number which can serve as a code in analysis.
For analysis one needs to think about which software is best to use: NutriSurvey/NutriCalc.	1	OK		

Remark	Number of times remarked	Result	Action taken	Rationale
Overall remarks				
Photographic food atlas is much needed and would be used in research.	4	OK		
There is a need for a photographic food atlas also for adults and other areas in Kenya (not only urban setting).	4	OK		
Need to review different urban settings for portion sizes estimates.	1	No		The weights of dishes are based on weights of portion sizes from two different areas in Nairobi: a low-income area and a middle-income area (Embakasi, Langata respectively).
The photographic food atlas should outline clearly its scope as now it is only limited to portions and able to show a variety of foods the children 9-14 years prefer.	1	Yes	Aimed to clarify the purpose of use of the atlas in the Introduction at the beginning of the atlas.	
The photographic food atlas as it is can be used for general studies that do not require quantifying.	1	OK		The purpose of the food atlas is to be used to aid adolescents in portion size quantification, but not directly for nutrient intake quantification.
Depict the sizes of portions first before the food photos themselves.	1			Did not understand what is meant.
There is need to specify that these are household portion sizes.	1			Did not understand what is meant. The portions are adolescents' portions based on weighed portions of adolescents in low- and middle-income communities.

6 Discussion

The literature was reviewed in order to understand how to develop a photographic food atlas and what may affect its usability and validity. Nelson & Haraldsdóttir's five step theory (13) was applied to the methodology of this research. A photographic food atlas consisting of 88 foods was developed based on triangulation of literature sources, expert knowledge and collected quantitative data (viewable here (77)). The usability of the atlas was tested among both adolescents and Kenyan nutrition professionals. The findings will be discussed in the following sections starting with discussing, what are the most commonly consumed foods and portion sizes and then moving on to discussing the main research question, the usability of the atlas.

6.1 Most commonly consumed foods and portion sizes

Based on the household survey in our study, the most consumed food group in both frequency and weights was starchy staples including *ugali*, rice and *chapatis*. This is in line with the findings of Mwaniki & Makokha (59), Gewa et al. (64) and Masibo (65), who all found that starchy staples were the food groups consumed the most in weight daily and also in frequency. Mwaniki & Makokha (59) reported the average daily consumption to be 358 grams for children aged 4-11 years in Dagoretti, Nairobi while Gewa et al. (64) reported the average daily consumption to be 515 grams for children with a mean age of 7 in a rural setting in the Eastern Province of Kenya. In our study the average portion size for *ugali* was 380 grams, for rice 204 grams, for *githeri* 200 grams and for a rice bean mixture 572 grams. These portion sizes are quite similar to, or within the daily intakes reported by Mwaniki & Makokha and Gewa et al.

Either vegetables (*Sukuma Wiki*, traditional vegetables, tomato and onion) or legumes (beans and green grams) were the second most consumed food in both frequency and quantity based on our household survey. This is in agreement with the literature as Mwaniki & Makokha (59) reported legume grains (beans, green grams and lentils) as the food group with the second highest daily amount consumed (293 grams) and vegetables (for example, cabbage, kale, spinach, traditional vegetables, carrots, onions, mushroom, tomatoes) as the third highest daily amount consumed (248 grams). Gewa et al. (64) reported legumes/nuts (dry kidney beans) to be the food group with the third highest daily amount consumed at 91 grams, though different types of vegetables were reportedly consumed in quantities less than 50 grams daily. Masibo (65) also reported vegetables as the second and fruits as the third most consumed food groups in frequency. In our study, an average portion size of beans was 145 grams and of green grams 138 grams and average portions of cabbage, *Sukuma Wiki* and traditional vegetables varied from 117-204 grams. These portion sizes are well within the daily

amounts reported by Mwaniki & Makokha, but are higher than those reported by Gewa et al. It must be noted that Mwaniki & Makokha's participants were from Dagoretti in Nairobi, whereas Gewa et al.'s participants were from Embu County in Kenya and thus they may differ in their physical and socioeconomic environment and food intake. Nutrient intake levels were also reportedly low among the schoolchildren. This could help to explain the differences.

Dairy products were most commonly consumed in the form of milk in tea (*chai*) in our household visits. A full cup of tea was 321-327 grams in a typical cup and the ratio of milk to water varied from 1:1 to around 1:8, meaning an average cup of tea would contain from around 36 to 164 grams of milk. This seems to be in agreement with Mwaniki & Makokha's (59) and Gewa et al.'s (64) results as dairy products (fresh or fermented milk) were reportedly consumed 188 g/d and 88 g/d respectively. Mwaniki & Makokha also reported daily intake of tea/cocoa to be 409 grams.

Based on our sample weights, the average portion size of chicken stew was 159g, beef stew 111g and goat stew 142g. Average fish portions ranged from 62 to 183 grams. Mwaniki & Makokha (59) found meat (chicken, fish, beef) intake to be 166 grams daily, whereas Gewa et al. reported mean daily intake of meat, fish poultry and eggs at only 7 grams. Our results are in line with Mwaniki & Makokha's; it seems intake of all animal products (apart from dairy products) was very limited in Gewa et al.'s study.

Overall, it would seem that our results follow a similar pattern to those reported previously in both frequency and quantity of food. However, as discussed earlier, daily intake is not directly comparable with portion size. Instead, a portion size would be expected to be smaller than the daily intake and thus the portion sizes obtained from our study may seem quite large compared to the literature. However, the participants in the earlier studies (59,64) consisted of younger age groups (4-11 years; mean age of 7) than the age group in this study, 9-14 years, and thus it is plausible that the daily intake and hence portion sizes should be bigger in our study. The low-income and rural settings of the earlier studies, may also explain a smaller average intake and a smaller portion size. In addition, Amougou et al. reported that in Sub-Saharan Africa, three daily meals will be eaten if possible, but more often meals are consumed once or twice a day meaning more food is consumed in one sitting, resulting in bigger portion sizes (14). Mwaniki & Makokha's results support this observation as they found that children in Nairobi consumed most of their daily energy intake during lunch (45%) and supper (45%) (59).

6.2 Usability of the atlas

General acceptability of the atlas was high among both adolescents and professionals as demonstrated by their Usability Scores classified as "OK" and "Good" respectively. This was also reflected in their verbal feedback indicating they were satisfied with the tool and happy to use it, but some aspects needed improvement. The feedback concerning various aspects affecting the usability of the atlas will be discussed next.

Variety of foods

Based on the usability survey feedback, most of the Kenyan staple foods were included in the atlas with a few essential foods missing such as arrowroot, cassava and some fruits. Comparison with the literature (59,64,65) supported the fact that most important staple foods were included. According to Nelson & Haraldsdóttir (13) it is important to include foods served in mounds, as sauces and that are slippery or wet. Many of the Kenyan staple foods such as rice, stews, *githeri* and *mukimo* fell into this category of amorphous and were included. Additionally, as recommended by Nelson & Haraldsdóttir (13), foods served in blocks, wedges and slices were included, such as *ugali*, cakes, pizzas and tubers.

Though Nelson & Haraldsdóttir (13) did not recommend including portion sizes that were available for purchase in quantities described as "easily identified from the description" such as biscuits, yoghurts and breads, we decided to weigh and include them in this atlas. This is because there is no existing nationwide database of weights for food items in Kenya and the weight data was needed for the main KENFIN-EDURA study. Many professionals specifically requested more types of breads and biscuits to be presented also for counselling purposes.

Portion sizes and shapes

The results relating to the adequacy of portion sizes were contradictory. Some adolescents displayed uncertainty and disagreement as to whether their largest and especially smallest portion sizes were depicted in the atlas. Yet nutrition professionals all agreed that portion sizes were small enough and one was unsure whether portions were large enough. The professionals noted that more portion sizes were needed for foods that had less than three portion sizes. This is in line with research, as Nelson et al. (33) do not recommend using one portion size picture, as subjects have difficulty estimating amorphous foods in fractions and multiples.

Based on the comparisons above, the portion sizes in our photographic food atlas are in line with those of previous research (59). However, the aim of a photographic food atlas is to depict the whole

range of portion sizes of the population from the 5th to the 95th centile (13). As we had very limited weights per food and the FFQ was originally designed to have three average portion sizes, we were not able to use the percentile method. Considering this and the feedback, it seems we may not have been able to present the whole range of portion sizes. However, Lombard et al. (26) also used three portion sizes with weights defined as the 25th, 50th and 75th centiles, thus not depicting the entire range and Turconi et al. (25) found that the use of a series of three photographs can produce accurate estimates with relatively small errors. Nevertheless, it is possible to obtain a wider range of portion sizes by allowing participants to select virtual portion sizes smaller, larger and in-between those presented, as reported by Amougou et al. and Bouchoucha et al. (17,20). This will be discussed in more detail below.

A reoccurring theme that arose from the verbal feedback from professionals and that is not discussed in much detail by Nelson & Haraldsdóttir (13), was the shapes the foods were presented in. Nutritional professionals noted that some portion shapes needed correcting to reflect typical Kenyan shapes. In other cases, portion sizes were not comparable as the shape of the mounds varied, for example *mukimo* and *githeri*. Nutrition professionals found the multiple pictures, portion sizes and shapes of fruits confusing. The shape of foods has been discussed in the context of the foods properties such as texture i.e. whether it is amorphous or a defined shape (39). There is limited and contradictory evidence on how the shape or texture of the food may affect portion size estimation amongst children. Lanarolle et al. (78) found higher accuracy and precision when participants estimated amorphous compared to non-amorphous foods, whereas Frobisher & Maxwell (29) found amorphous foods like mashed potatoes and spaghetti least accurately estimated. Interestingly, Thoradeniya et al. found that line diagrams, depicting the shape of the food were slightly more accurate than photographs for estimating non-amorphous foods (31). These findings imply that the shape of the food can conceivably influence how a child estimates a portion and thus the usability and accuracy of the atlas.

Photography

Nutrition professionals commented on the dark and pixelated quality of the photographs. This was obvious from the outset, as the photographs had not been decompressed properly and printing quality was poor. Photographs had been taken in the field in varying conditions with a free hand. Though a 45-degree angle was attempted, it was noted by professionals that photography conditions were not standard and it hampered comparison of portion sizes. Nelson & Haraldsdóttir (13) do not discuss photography conditions but many studies reported photographing in standardised conditions using a constant angle, ISO and photography distance (17,24,25).

The adolescents remarked on enjoying looking at the pictures and most adolescents strongly agreed that they were able to recognise the foods, however, in practice, it was noted that many were unable to pick out the correct foods. This may in part be due to the photographs being blurred, or the small size of the photographs. However, it may also be related to participant characteristics, as Brito et al. (32) found that the proportion of adolescents who correctly identified all foods was higher in adolescents aged 15-18 years compared to those aged 11-14 years. This will be discussed in more detail below.

Layout

One adolescent and one nutrition professional disagreed that pictures were big enough in size. However, in their verbal feedback, professionals stated the pictures were unclear and too small. As mentioned, one explanation for children's inability to recognise foods, could be small picture size. Lombard et al. (26) and Huybregts et al. (79) found that life-size pictures produced more accurate estimations, though Thoradeniya et al. (31) did not find any increased benefit of using life-size over smaller images. Nonetheless, Nelson & Haraldsdóttir (13) do not recommend life-size images, as it makes the atlas bulky, which will make it burdensome to use for both interviewer and interviewee.

Many professionals recommended that the order of foods should be in line with the FAO categorisation of foods and preferred to have the weight sizes directly next to the pictures. However, Nelson & Haraldsdóttir (13) do not recommend placing weights or descriptive names, such as "large" or "small" next to portion sizes as social desirability and behavioural norms may affect portion-size estimation (39).

Participants: Adolescents

Nelson & Haraldsdóttir (53) state that participant characteristics such as age, gender, BMI and education level may affect a participants ability to accurately estimate portion sizes. The number of participants was smaller than anticipated in the usability survey and thus it is difficult to evaluate, how these various characteristics may have affected usability for individuals. However, some of the researchers' observations and adolescents' own opinions of the user-experience are discussed below.

The FFQ interview took from one to one and a half hours to complete. It was noted that the adolescents were rather fatigued after answering the FFQ and using the photographic food atlas. This is a long time for children or adolescents to focus and the psychological processes taking place such as conceptualisation and recalling from memory can be mentally challenging. Nelson & Haraldsdóttir (53) suggest that children under 12 years may be less able to create the necessary mental constructs

to use such a tool, as it requires thinking back over the period of a week (sometimes longer). This proved a challenge for the adolescents. In previous studies the time elapsed from consuming a portion size did not affect accuracy of estimation (37). However, it should be noted that adolescents were recalling a certain portion size, which may require less cognitive effort than estimating an average portion size.

The challenge associated with the task, was also reflected in the Usability Survey results, as half of the adolescents disagreed when asked if they could use the food atlas by themselves. In many cases, support in recalling portion sizes was required from the mothers. Observations also verified that the adolescents needed help in identifying the correct portion sizes.

As mentioned before, Brito et al. (32) found that the ability to recognise foods was significantly higher in adolescents aged 15-18 years compared to those aged 11-14 years. There are many possible mechanisms via which age can affect the ability to recognise foods, such as, increased attention span, better literacy, higher education level and more developed cognitive processes. For example, Huybregts et al. (79) found education was linked to better accuracy in estimations.

Adolescents also seemed to struggle with the concept of the Likert scale in the usability questionnaire and at times, their answers were contradictory to their verbal feedback, or observations made by researchers. This may have also been due to fatigue, or the abstract nature of the Likert scale that requires many complex cognitive processes (80).

Participants: Nutrition professionals

All professionals agreed they would use the atlas in their work as nutritionists, especially after improvements were made. Clinical nutritionists expressed an interest in including nutrient data for the different portion sizes as well as many different varieties of the same food. Some of these comments were not at all related to the main aim of the atlas, i.e. to aid in assessing portion sizes. It could clearly be seen that some were not thinking about the usability from the researchers' point of view. However, their views were also important and valid feedback.

Experts had many questions surrounding the purpose of the photographic food atlas and how it should be used. Their feedback demonstrated that there was a lack of prior experience in using a photographic food atlas for quantitative food intake assessment. This feedback from both professionals and adolescents opened up new possibilities for the use of the atlas in counselling, community and educational work and also called for clearer, more detailed instructions of use.

6.3 The second version of the atlas

Based on feedback from adolescents and professionals, the steering group met and decided on the changes to be made to the second version of the atlas (viewable here (81)). What follows is a summary of the changes made and the rationale behind them.

Most of the food items mentioned as missing such as sausages, tubers, cakes, sweets, biscuits, vegetables and breads have been included in the second version of the atlas as well as more portion sizes for existing foods. The number of food items included was increased from 88 to 173 (Appendix 12). All foods could not be included due to limited resources. The focus was put on the foods that were most important to the target group of the atlas, as well as providing a variety of foods of different shapes and textures. This was recommended by Nelson & Haraldsdóttir (13) and will allow the estimation of other foods that weren't included in the atlas. It was seen retrospectively in the larger KENFIN-EDURA study, that the greater variety of biscuits and breads did not necessarily improve the usability of the atlas for research purposes, as it made the atlas longer and more burdensome to navigate as also noted by Nelson & Haraldsdóttir (13).

The steering group decided not to alter portion sizes of amorphous foods. There were many reasons for this, including conflicting feedback on adequacy of portion sizes; restrictions in time and resources did not allow more weighing sessions. The steering group also decided against changing calculations to make the smallest portion smaller, as it would have increased the proportionate difference between portions A and B and between portions B and C (as B is 100% bigger than A, whereas C is 50% bigger than B) . However, more portion sizes were added to some foods that come in pieces and single units. Furthermore, it was decided that in the main KENFIN-EDURA study, the participants were allowed to indicate virtual portion sizes smaller, larger or between the portions presented in the pictures for amorphous foods, which will have allowed a wider portion size range. Participants were also allowed to report fractions or multiples of foods served in units such as pancakes or fruits, as it is the most natural way to indicate portion size.

The shapes of portion sizes were changed according to the feedback of the professionals. The portions of foods served in mounds, such as *githeri* and *mukimo*, were presented in identical shapes to enable accurate comparability between portion sizes. The portions of certain other foods were changed to represent those found at Kenyan markets and restaurants, for example, tilapia fish is often served in portions of head, middle and tail and watermelon is sold in thin lengthwise slices. In addition, the number of different types of each fruit presented was reduced to simplify the use of the atlas according to the professionals' wishes and shorten it to make it less burdensome to navigate.

To ensure better quality of pictures and to enable reshaping of portions, the foods were photographed again in a food laboratory at Kenyatta University. This time, photography conditions were kept standard. The camera used was a Nikon D3200, Lens 18.0-55.0mm f/3.5-5.6, ISO 200 and was on a tripod 60cm away from the food items, at an angle of 45 degrees. This ensured better lighting and standard photography angle and distance, which ensured better comparability between pictures.

The food group classifications and order of food was changed to represent that of FAO. These new food groups were colour-coded, and the edges of the pages were colour-coded for easy use in the field. The number of food items per page was reduced from four to three to ensure larger picture size and a better viewing experience. In addition, formatting of pictures was improved to make sure that they were not compressed and pixelated as was the case in the first version. This enhanced the clarity of the photographs.

The introduction to the food atlas was updated to better explain its purpose of use. However, it was also decided that more detailed instructions should be distributed with the photographic food atlas (Appendix 13/still being developed). These instructions should describe how the photographic atlas should be used for different purposes such as research (to support a 24-hour recall interview or FFQ interview), counselling and as an educational aid and should include recommendations on how adolescents should be supported in its use. A clear instruction manual will enhance the introduction of the tool to the wider nutrition and health community in Kenya and ensure that it is used in the correct manner for each purpose.

Based on the adolescents' insecurity about using the atlas themselves and the researchers' observations in the field, it was decided that the adolescents of the age group in question should always be guided when using the atlas and a guardian should be present to help if needed. To combat fatigue and improve concentration, in the larger KENFIN-EDURA study, participants were allowed to take breaks during the FFQ interview and were presented with a small snack.

6.4 Limitations and strengths

Representativeness of samples

Nelson & Haraldsdóttir (13) stated that portion sizes should be based on weighed food records of the population and age group in question and the list of most common foods should be collected from these surveys and a variety of other sources. As there was no national food consumption data available in Kenya, the most commonly consumed foods and the average portion sizes of these foods were determined largely based on the household survey of twenty-one 9-14-year-olds in Nairobi and

cooking demonstrations with their mothers. As food choices and portion sizes can be affected by many different factors such as age, sex, SES, physical environment, religion and culture, it is important that the sample on which the household survey is conducted is representative (82–86). The sample was a convenience sample and thus not randomised, so there is a possibility that it does not accurately represent the target population of Nairobi.

Nevertheless, the aim was to obtain a representative sample in terms of sex, age and the different areas representing different SES. Sex and different ages were evenly represented in the household survey data of twenty-one adolescents. However, a possible source of error is that accurate age verification of the participants was not always possible, as most were not able to present birth certificates, or other forms of identification. It is possible that some of the participants were younger or older than reported and did not fall into the age group 9-14 years, as estimation of age can be challenging due to stunting in children and adolescents in Kenya (57).

Participants were recruited evenly from two different study areas, Embakasi and Langata, to represent two different SES groups (low and middle). The parents' education levels and occupational positions – measures which are often used to determine socioeconomic status (57) – support the differences in SES between the two areas. The education level was higher in Langata compared to Embakasi in both mothers and fathers, excluding one household of Somali ethnicity in Langata, where the mother had not completed primary education and the father had reached primary school level. There were more unemployed, housewives, casual labourers and small business owners in Embakasi compared to Langata, where there were more parents working in business or had a formal salary-paying job. The Somali family were outliers in Langata as the mother was a housewife, whilst the father was an Islamic religious leader. These results give support to the assumption that the participants in Embakasi represent lower socioeconomic status and participants in Langata represented middle socioeconomic status.

However, only low- and middle-income areas were included in this study and the extremes of the socioeconomic spectrum were not represented. Our sample did not include participants of a high socioeconomic status, nor did it represent the lowest socioeconomic groups, as there are many areas in Nairobi of much lower socioeconomic status, than the specific ward of Kayole visited in Embakasi Central in this study, as explored in the report by the Kenya National Bureau of Statistics (87). Both the highest and lowest socioeconomic groups may consume foods and portion sizes that are specific for their SES groups and thus the atlas may not be applicable to these SES groups. For example, based on our market survey and interviews, in some of the poorer areas of Embakasi, chicken feet and meat from the cow's head are consumed, which were not included in this atlas. Mwaniki et al. (88) also

reported that children in orphanages were three times more likely to have inadequate calorie intakes compared to non-orphanage children. This supports the notion that children of very low SES may have smaller portion sizes than the ones presented in the atlas.

Details on the cultural, ethnic and religious backgrounds of the participants were not collected in the background information questionnaire and therefore, all knowledge was obtained by observation only. One family that participated was noted to be of Somali ethnicity and Muslim religious orientation, however, it was also noted that the two families who refused to participate in the household surveys were also of Muslim religious orientation. This raises the question of possible under-representation of participants of certain religious and ethnic backgrounds. Kenya is a large and diverse country in terms of ethnicity, tradition, religion and environment (57) and multiple studies have found that culture and traditions related to different ethnic groups have an effect on dietary practices in Kenya (89–93) (discussed in more detail in section 6.5). As no official data was collected on the ethnicity and religions of the participants, it is unknown whether the sample is representative of the ethnic groups and religions within Nairobi and thus some commonly consumed foods of certain ethnic groups may be missing. It is important to note that the list of commonly consumed foods was specifically made for the Nairobi context and therefore, may not be representative of, or applicable to the different geographical regions, particularly rural areas of Kenya. Data was also collected in June, so foods from other seasons may have been missed. However, other sources such as the nationwide government reports (National Guidelines for Health Diets and Physical Activity (4) and Kenya National Clinical Nutrition and Dietetics Reference Manual (66)) and studies reporting daily intake of children and adolescents in Western Kenya (Millennium Villages Project in Siaya (65)), Eastern Kenya (rural setting in the Eastern Province of Kenya (64)) and Nairobi (Dagoretti (59)), verified that the commonly consumed foods in the household survey, were also consumed elsewhere in the country and no important seasonal foods had been missed.

The aim was to conduct the usability survey with twenty adolescents, however, this was not achieved. Only eight adolescents were interviewed due to time limitations. Participants were also not evenly distributed across age, gender and study areas in the usability survey. Additionally, it was noted, that the study area in Langata was typical of a low SES area similar to Embakasi based on the physical environment and housing situation. However, when looking at parents' education and occupation level it would still seem that they were of higher SES than the participants in Embakasi, though it must be taken into account that data for some parents was missing.

Eight participants is not a large enough sample to conduct statistical analysis on results from the usability survey and thus, results must be interpreted with caution. The reason for choosing a

quantitative survey was based on the aim of obtaining responses from at least twenty adolescents. It must be questioned, whether gathering quantitative results from such a small number of adolescents and professionals, was the best method to determine the atlas' acceptability and usability. Nevertheless, qualitative data was also collected via open-end questions, observations and from the verbal feedback of both adolescents and adults in order to compliment the quantitative data. However, in hindsight, a qualitative approach should possibly have been emphasized more, in order to gain greater in-depth knowledge of the adolescents' and professionals' thoughts and opinions on the atlas.

Portion sizes and range

As discussed, the small sample size and the fact it wasn't randomised may introduce bias and thus mean that portion sizes are not representative of the target population. This issue is accentuated when taking into account that, though twenty-one adolescents were interviewed for the household survey, the overall number of portion sizes weighed per food item remained much lower as it was not possible to obtain a portion size weight for each food from item each adolescent. The number of weighings per food item, from which the portion sizes were calculated ranged from 0-9. Furthermore, though an equal number of household visits were conducted in Embakasi and Langata, we faced difficulties in recruiting participants in Langata. In the middle-income area of Langata, people live in gated communities with gated houses. First, one must gain access to the compound and then access to the houses, which are also protected by a high wall and gate. Often, we were greeted by a housekeeper, who did not have authority to allow the adolescent to participate and even when met by parents, we were often not permitted inside the house. The parents of the adolescents in Langata worked long days during the week and at the weekend had many activities such as church and sports days at the school. Adolescents did not come home from school during lunch times, as was the case in Embakasi, so they could not be interviewed during the week either. Therefore, we were rarely able to attend mealtimes and, in many cases, had to resort to the adolescent describing their food portions and showing them with the aid of their cups, bowls and plates. This reduced the number of weights obtained for each food from Langata which might have further skewed the portion sizes.

The scale (Ramtons, max 5000g) used in weighing the portion sizes may be a possible source of error. Calibration was challenging in the field as level surfaces were not always available and calibration was performed with a 200g bag of salt. During measuring, the scale would sometimes alternate between two numbers. Hence, it is possible that weights were not entirely accurate to the gram. The weights in the photographic food atlas were rounded to the closest gram, but it might have been more appropriate to round the portion size weights to the closest weight divisible by five as has been done by Nissinen et al. (42) in their photographic food atlas for Finnish preschool-aged children. In

addition, some small errors were noticed in the second version of the atlas (Appendix 11) that have an effect on the portion size range depicted.

These aspects affect the accuracy of the average portion sizes A, B and C and the range of portion sizes presented in the photographic food atlas. A larger sample size and higher number of weighed portions per food item as well as an accurate weighing scale would have improved the estimates of average portion sizes. These may have affected the ability to rank adolescents by their food intake. However, as there is no official national-level data on portion sizes and food intake available for adolescents or adults in Kenya, the data obtained can be considered a credible first step towards acquiring accurate portion size data. Furthermore, as discussed above, it is possible to capture a wider range of portion sizes by allowing participants to select virtual portion sizes between, smaller and larger than those in the photographs.

There are different ways to determine the weight of the virtual portion sizes. For example, Bouchoucha et al. (20) defined the portions that fall between two different portion sizes as their average in weight whereas Amougou et al. (17) used the three sigma rule, they took the average portion size as the mean and the large portion was defined as mean+1SD and small portion as mean-1SD leaving the imaginary portion sizes to be mean+/-0.5SD and mean+/-1.5SD. Due to the way the small and large portions were defined in this photographic food atlas, the three sigma rule cannot be applied. Besides, the number of weightings were so few, that standard deviation is not applicable. Instead it is recommended that the virtual portions *between A and B* and *between C and B* are the averages of their respective portion sizes (see Appendix 13). *Less than A* could be defined as half of portion A, wheras *more than C* could be one and a half times C. Adding more answer options can increase the ability to rank participants according to their food intake, as it would create more variety between them. This method of determining virtual portion size was utilised in the main KENFIN-EDURA study (results not yet published) for amorphous foods. Fractions and multiples could be indicated for the foods that came in clear units as this is the most natural way to quantify such foods.

Validity of the usability questionnaire

The questions used in the usability questionnaire and the method to determine the overall usability score were based on the SUS (74). However, it is important to note that the Usability Score has been formulated for the purpose of the SUS and those specific questions (75). The average Usability Score 68 and other cut-off values are based on studies using these specific questions (73). Hence, it can be argued that the Usability Score should not be used or adapted to this study. However, in this study it

was used only as a crude measure and general indication of satisfaction of the atlas, and verbal feedback and observations were analysed as well.

As mentioned before, some of the answers of the adolescents and professionals to the Likert Scale questions were contradictory to the verbal feedback given or observations made. It was noted that adolescents struggled with the concept of the Likert scale. The adolescents would say they disagreed to a statement aloud, but would then point at number 3 on the Likert scale with the description *neither agree or disagree*. It was noted that both adolescents and professionals were reluctant to use the answer options *strongly disagree* (=1) and *somewhat disagree* (=2) though verbally they clearly disagreed. It was also noted that the meaning of some statements had to be explained out loud to the professionals, for example, it was unclear what was meant by "small enough" or "large enough". This may indicate that some of the wording in the statements was unclear.

It may be that the Likert scale poses a cognitive and linguistic challenge for adolescents between the ages 9-14 years. Gelman et al. (94) argued that children may not be able to think about concepts on a scale but think more dichotomously. Mellor & Moore (80) examined 6-13-year-old school children's ability to use a variety of Likert response formats to respond to concrete and abstract items and found that when using numbers to represent strong agreement to strong disagreement, participants were inconsistent compared to the yes/no answers. The word-based response formats produced higher levels of concordance with the yes/no format for all age groups, but even this was less than 100%. It was also noted that the agreement between the Likert scale method and the yes/no answers was higher in older participants, compared to younger participants, when the question was about an abstract concept. This would suggest that younger children struggle with evaluating their opinion or stance on more abstract problems. This may indicate that the younger participants in this study struggled with the abstract questions, or alternatively participants were confused by the 1-5 scale, as our answer options included both the word-based response and the number. In addition, as discussed above, it was observed that by the time the adolescents had completed the FFQ, a mentally challenging task, they were quite fatigued. This may have contributed to lack of attention which in turn will make complex cognitive processes challenging.

Additionally, there were some challenges related to languages and translations. As reported by the Kiswahili-fluent members of the research team, there were challenges in deciding how to translate the verbal answer options to Kiswahili. It is also important to note that Kenya consists of many tribes and ethnicities whose first language may be their own tribal language instead of Kiswahili or English. This may further hamper understanding of the Likert scale options especially as Mellor and Moore (80) stated, participants rely heavily on the word-based response options rather than the numbers.

The culture and prevailing norms may also affect the way participants answer. The accuracy of Likert scale questions has not been researched in Kenya or any East-African setting to our knowledge. In some cultural guides (95,96), it is reported that the communication style in Kenya avoids giving blunt or direct negative answers, which might explain the adolescents' and professionals' reluctance to pick the answer options that communicate disagreement. This explanation is supported by the fact that professionals also avoided using the response options voicing disagreement and were very lenient when grading on the Likert Scale compared to the verbal feedback that they provided. It is important to note that both adolescents and professionals answered the questionnaire individually in the presence of the interviewers so, though no names were recorded, answers were still not truly anonymous. The presence of interviewers may have affected willingness to give truthful feedback.

In summary the results of the Likert Scale questions must be interpreted with some caution, not only because of the small sample size but also because the usability questionnaire has not been validated. In future, if quantitative results need to be obtained on usability, a different presentation of questions is recommended, for example, questions with yes/no answers should be considered, especially when interviewing children or adolescents. In addition, measures should be taken to ease the mental demands of filling in the FFQ and the usability survey by, for example, offering breaks and snacks.

Triangulation

Though the results from the Usability Questionnaire should be interpreted with care, a strength of this study is its triangulation of various research methods. By combining multiple sources of data and methods, we hoped to overcome possible bias and errors that would result from using the limited data from a single source. In the case of the Usability Questionnaire, qualitative data in the form of verbal feedback and observations were used to corroborate results, or highlight issues that may otherwise have been missed.

The list of most commonly consumed foods among adolescents was based on literature (59,64,65), official Nutrition guidelines and manuals (4,66), the FFQ developed by Fibrepro already used in Kenya, data collected during the household visits and market surveys (Phase 1) as well as feedback from Kenyan Nutrition Professionals (Phase 3).

As discussed by Lombard et al. (26), qualitative data is important in order to create a culturally-specific and accurate tool. Arranging the cooking demonstrations with the mothers of the adolescents enabled us to note down the accurate preparation methods and take pictures of accurately prepared Kenyan foods. The Usability Survey offered an opportunity to further discuss the correct depictions of portion sizes and shapes in the Kenyan context. This is on a par with the methods used by Lombard

et al. (26), as they also arranged FGDs with experts and local women to discuss the usability of their atlas.

Multiple uses of the atlas

After receiving feedback from the adolescents and professionals, it was realised that the photographic food atlas can have many additional applications and purposes of use, such as in counselling or as educational material for children and adolescents. These uses were considered when developing the second version and we wanted to enable the use and application of the photographic food atlas in as many ways as possible to benefit Kenyan nutrition research, counselling and education. For example, a variety of different breads and biscuits were added for counselling purposes, as suggested by the clinical nutritionists. However, not all suggestions could be acted on, for example, including nutrient content of the different portion sizes. Instead, we suggest utilising the recently developed and very comprehensive Kenya Food Composition Tables (97) to obtain nutrient intake data.

Our primary aim was to develop a quality tool for research purposes for both the KENFIN-EDURA study and future Kenyan nutrition research and thus we prioritised developing it to serve as an aid for filling in the FFQ. Consequently, this meant that some compromises were made when developing the atlas as we tried to make sure that it could serve for a multitude of different purposes. For example, it was found in our KENFIN-EDURA study (results not yet published), that adding a large variety of breads and biscuits, or changing the order of the food to follow the FAO classifications rather than the order of the FFQ, did not necessarily improve the usability of the atlas. However, a notable strength of the atlas and something that improves its usability for a variety of purposes and in a variety of areas in Nairobi is that all texts in the atlas are also in Kiswahili.

6.5 Reflections on developing a photographic food atlas in a LMIC setting

Nelson & Haraldsdóttir's (13) five-step theory is clear and takes into account a wide variety of aspects of developing a food atlas, however, a lot more research has been conducted on developing and validating a photographic food atlas since the 1990s. For example, Nelson & Haraldsdóttir (52) suggest that the accuracy of portion estimation could be influenced by age, gender, BMI and portion size. However, more recent studies have not found age or gender to be a confounding factor (18,25,79). Moreover, Nelson & Haraldóttir's (13) instructions focus on studies conducted in high income countries and thus their steps are arguably better adapted to high income countries and contain certain assumptions about the food culture and setting that may not applicable to a LMIC setting. There are many assumptions in the steps that cannot be taken for granted in LMICs and thus it may

be of use to have a sub-set of more detailed instructions for developing a photographic food atlas in LMIC settings.

The first assumption is that national-level data on dietary intake and portion sizes is available. As demonstrated in the case of Kenya in this study, there was very limited data available on dietary intake (7). This issue was also identified by Thoradeniya et al. (31) in Sri Lanka where there was no weighed food data from which to derive the portion sizes. In our case this meant relying on a limited number of portion weighings; while Thoradeniya et al. (31) based their portion sizes on dietary recall studies using standard household measures.

Another assumption is that the diet is homogenous across the population. Nelson & Haraldsdóttir (13) do not mention how to take into account various ethnic groups and religions and their dietary customs. Ethnicity, tradition, environment and religion have a big effect on dietary habits in Kenya (89–93). According to the 2014 KDHS report (57), the main ethnic groups in Kenya include Kikuyu (22%), Luhya (16%), Kalenjin (12%), Kamba (12%) and Luo (10%). However, the distribution of these ethnic groups varies from area to area in Kenya. In the Socio-Economic Atlas of Kenya (98) it is reported that Kikuyu (29%) are the largest community in Nairobi, with Kamba being second-largest and Luo third-largest. Hansen et al. (91) found that dietary patterns and food groups contributing to energy intake differed significantly between the Luo, Kamba and Maasai tribes. For example, almost 80% of the Luo consumed fish daily compared to 0-2% among the Kamba and Maasai whereas twice as many Maasai (88%) consumed dairy products compared to the Luo (43%) and Kamba (40%). This study was conducted in the rural areas of Bondo district (Luo), Kitui district (Kamba) and Transmara district (Maasai) and the differences in their food choices reflect their livelihoods and environment, as the Maasai are pastoralists and the Luo live close to lakes where fish is abundant. Hence ethnic groups may use local ingredients not available elsewhere and this may affect the ingredients and preparation methods for a dish, for example, *mukimo* can be made from *Irish potato* and peas or sweet potato and corn depending on the area. Religion can also affect dietary habits, for example restricting certain foodstuffs like pork and crustaceans (86). The World Factbook (99) estimates that 83% of Kenyans are Christians and 11% are Muslims. The main religions have different geographical distributions in Kenya, with Islam as the main religion in East and North-East Kenya (98). In our study we noted the presence of many different ethnicities in the study areas and that this seemed to have an effect on food choices even while living in Nairobi. For example, a Luo family reported consuming a lot of *omena* (a small fish known as Silver cyprinid) and the Somali family reported consuming camel milk and Somali pancakes.

Nelson & Haraldsdóttir (53) suggested that level of education may influence perception and conceptualisation skills. Huybregts et al. (44) found that subjects who attended school were 1.92 times more likely to choose the correct photograph, whereas Korkalo et al. (27) found an insignificant marginal association between education and estimation accuracy and Venter et al. (18) found none. Literacy levels (100) and the average of completed years in education (101) of children and adolescents are lower in LMICs compared to high income countries. Hence, if education does play a role in estimation accuracy, this would require specific attention in LMICs.

Venter et al. discussed the importance of 'pictorial literacy' in the ability to use pictures to estimate portion sizes (18). They state that though pictorial literacy can occur independently of the development of literacy itself, literacy and thus education level is an important factor in determining the ability to interpret pictures. Both Venter et al. (18) and Korkalo et al. (27) highlighted that in the rural and remote areas of LMICs there are very few pictures available in people's daily environments, which may mean they are not used to using pictures. For this reason Lombard et al. (26) and Venter et al. (18) concluded that life-size pictures were crucial to achieving accurate portion estimations. However, Korkalo et al. and Thoradeniya et al. found that life-size pictures did not improve estimations (27,31). On the contrary Korkalo et al. speculated that because pictures do no play an important role in the everyday life of adolescent girls in Mozambique, the life-sized pictures may actually have led the participants to perceive the large mounds or balls of staple foods as 'too large' and thus may have created a source of error in the estimation. Based on the verbal feedback we received from the adolescents about enjoying looking at the pictures and their desire to learn from the pictures, it would seem that colour pictures were somewhat of a novelty to the adolescents in this study too, especially in Embakasi.

Another implication of little exposure to pictures is how the participants are guided in the use of pictures. Based on our results, the 9-14-year-old participants did not feel confident in using the atlas on their own, and thus a guardian and/or researcher should be on hand to help. The method of administering the food atlas may be of higher importance in LMICs. It may be necessary to ensure that a clear protocol is developed and that research staff are well-trained in the use of the atlas in LMICs. This also includes the issue of whether participants are allowed to select virtual or fractional portion sizes. In a few studies in Cameroon, South Africa and Burkina Faso it was found that participants overestimated the small portion sizes and underestimated the large portion sizes they were asked to estimate, known as the 'flat slope phenomenon' (17,18,44). It was suggested that this may be due to the fact that largest and smallest virtual portion sizes were rarely selected.

Other issues are related to the temporal, special and social context in which the questionnaire and atlas are administered, these include whether it happens before or after a meal and whether participants eat the meal or just look at it and to who serves the portion. Beasley et al. found significant differences in portion size estimates when school children assessed their usual portion size depending on whether it was before, or after lunch (102). However, it seemed not all subjects were affected by their level of satiety. Robinson et al. found that lower portion estimation errors occurred if the subjects served themselves, compared to if they were served (103).

We noted a few other issues concerning the food culture in LMICs. Firstly, the kitchen utensils may differ in LMICs to those found in high income countries. The foods in the pictures should be presented in the types of bowls and plates they most frequently use in the culture in question. This was why we took pictures of the most common kitchen utensils during our household survey. In addition, many people may eat using a spoon or by hand as opposed to a knife and fork. Huybregts et al. (44) noted that, in Burkina Faso, the women in rural areas ate from a shared bowl which can create additional difficulties for participants when trying to estimate portion sizes. We found it was also important to accurately depict portion shapes, which may differ to the portion sizes and shapes in high income countries. For example, in Kenya watermelons are cut lengthwise and sold in thin slices on the markets. Another thing we realised and was also noted by Amougou et al. in Cameroon, is that meal patterns may not follow the breakfast, lunch and dinner pattern found in high income countries (17). One should not assume that the participants consume three meals per day (or necessarily use these names for the meals), as in times of scarcity there may only be one, or two meals per day and there can also be a big variation in portion sizes due to the seasonal availability of food. Such great variation in portion size may further complicate estimation of an average portion size for a participant. These are all important aspects to keep in mind when doing field research.

Finally, it is assumed that nutrition professionals have used, know how to use and are willing to use a photographic food atlas in their research. In this study, it became apparent that although nutritional professionals had possibly used the South African food atlas there was still some uncertainty and lack of understanding of how to use a photographic food atlas to quantify portion sizes. This highlights the importance of Nelson & Haraldsdóttir's (13) Step 2, consulting the local researcher community widely and first obtaining an understanding of their opinions and needs as also noted by Lombard et al. (26). Hence, it should not be assumed that researchers will know how to use the atlas as an aid for a 24h recall or FFQ and thus plans should be made on how to instruct the users on the correct administering methods.

As can be seen from the examples above, there are many issues related to the development and utilisation of a photographic food atlas that are of specific importance in a LMIC setting and, for example, Nelson & Haraldsdóttir's instructions (13) do not take these into account. Hence, specific guidelines could be compiled to instruct researchers on how to develop a photographic food atlas in these settings. Lombard et al. (26) have also discussed many of these issues in their detailed description of developing a photographic food atlas in South Africa. They highlighted the importance of using qualitative methods when developing a photographic food atlas in order to be able to accurately represent the food culture and portion sizes.

6.6 Recommendations for future research

It is crucial that this atlas is validated to determine the presence and direction of bias in terms of portion size estimation accuracy. The photographic food atlas has been used in the main KENFIN-EDURA study in Embakasi and Langata amongst 9-14-year-olds (results not yet published) and hence the first priority is to validate it amongst this population.

Nelson & Haraldsdóttir (53) have discussed the design of studies to validate portion size estimates. Validation studies should have one of the following aims: the assessment of errors related to determination of food portion sizes *per se,* or the assessment of errors in estimates of food consumption and nutrient intake in population studies where the photographs are used. Studies with the first aim, aspire to provide information on the estimation error for each food/photographic series separately, whereas studies with the second aim, provide information on the overall error introduced when the photos are included as part of the dietary instrument. The key elements are the same in both study types, firstly to compare the food atlas to a bias-free reference measure, secondly to administer the food atlas in the way it will be used in the main study (24h recall interview/FFQ survey) and thirdly to have at least a sample in the validation study which shares the same demographic characteristics of the main study population.

The main aim of any validation study is partly determined by the dietary method that the portion size photographs are adapted for. In the case of the main KENFIN-EDURA study, this photographic food atlas has been used as a tool to fill in an FFQ so the second study type is recommended to determine how the photographs contribute to misclassification of subjects according to estimates of food consumption or nutrient intake. A comprehensive validation study measures perception, conceptualisation and memory (53). Perception refers to how accurately a participant can relate a quantity of food in reality to the amounts depicted in the photograph, whereas conceptualisation refers to how accurately a participant can relate a quantity of food that is not present to a photograph (13).

Memory plays a role in how accurate conceptualisation is. As the FFQ measures usual average portion sizes, conceptualisation and memory should be the main aspects tested in any future validation study of this atlas. However, if resources are available, it is also recommended that perception be tested in a subset, to evaluate the accuracy of a few crucial individual pictures.

The first key element is to compare the food atlas to a bias-free reference measure. As the FFQ measures food intake over a longer period, the validation should compare estimates of usual consumption based on an FFQ with records, which reflect food consumption or nutrient intake over a corresponding period. Nelson & Haraldsdóttir (53) recommended administering the FFQ using the food atlas and with another estimation tool, for example, household measures. The results should then be compared to a validated, weighed record of all the foods consumed during the reference period. The weighed record of all foods should be from a longer duration than a week. It is important to note that the records must include an adequate number of entries for the foods for which an estimate of usual portion size is being assessed and leftovers should be recorded and subtracted from the initial portion size. This approach only validates the atlas to be used alongside the FFQ so, if the atlas is also to be used as a tool to support 24h recall interviews, its validity should be tested in these circumstances too. This would require performing two 24-h recalls of diet from the previous day, one with the photographs and one with household measures (53). The reference measure is a valid weighed record of all food consumed on the days that the 24h recall was performed. Sources of error in the reference measure used must be taken into account, for example, self-weighing may lead to reduced intake, or technical errors in using the scale.

The second key element is to administer the food atlas as one would in the main study. The FFQ and photographs should be administered in a context that replicates the context of the larger study. There are many aspects about the practical implementation of the study, such as, will the participant view or consume the foods, who serves it, do they report on serving size or portion size, will the participant be given clear instructions on how to fill in the questionnaire/atlas and are the interviewers trained in the administration of the photographs. It is also important that participants are not aware of the purpose of the validation study and do not know that their ability to estimate portion sizes is being tested. When validating this food atlas, the FFQ should be administered to the participants according to the same protocol that was used in the main KENFIN-EDURA study.

The third key element to consider is the representativeness of the sample. Previous validation studies have suggested that certain groups differ in their ability to make effective use of photographs (53). Age, gender, weight and BMI, education level, socioeconomic status and ethnic groups should be taken into account. If the impact of these factors is to be investigated it is important to ensure a large

enough sample to allow analyses to be undertaken in each subgroup. The number of subjects to be included in a study overall will depend on the variance of the observations. Appropriate power calculations should be carried out to ensure that the sample size is adequate. In the case of this atlas, it should be validated in a sample of 9-14-year-olds in Nairobi living in Embakasi and Langata of varying BMI, gender and educational levels. It would also be good to have a representative sample of the ethnic groups often found in Nairobi.

As demonstrated by the validation studies mentioned earlier (12,17,24,25,27–32,34,37,38,41) results can be presented in a variety of ways, for example, as the degree of error between the actual and estimated weights, estimation accuracy of the tool or percentage of overestimated, underestimated and correctly estimated food, or the percentage of participants who overestimate, underestimate or correctly estimate foods. Nelson & Haraldsdóttir (53) suggest a variety of ways, however, in this case classification by quantiles or Bland-Altman plots may be suitable. Classification by quantiles (for example, tertiles or quartiles) allows exploration of the extent of agreement or misclassification between the actual and reported measurements. Because FFQs are used to rank participants by their dietary intake, it is important to know how accurately the participants are ranked according to their food intake when using the photographic food atlas for portion size estimation. On the other hand, Bland-Altman plots reveal the difference between two measures against their mean. This would allow plotting results from different sub-groups of the sample in order to see if there are differences in accuracy of portion size estimation, as done by Korkalo et al. and Bouchoucha et al. (20,27).

Based on the results of the validation it may be possible to identify subgroups for whom the photographs are inappropriate, and it may allow correction factors to be used for the population as a whole, or for certain subgroups if errors are systematic. It is important to note that the applicability of the photographic food atlas depends on the sample it is validated on. For the purpose of the KENFIN-EDURA study, it is be important it is validated amongst 9-14-year-olds of low and middle socioeconomic status in Nairobi. However, if resources are sufficient, the atlas could also be first piloted and then validated in other urban areas of Kenya and/or a wider age group. Depending on the results of piloting and validating, the atlas may be applicable for use in these new areas and age groups after some minor modifications and/or correction factors.

This photographic food atlas is the first step to creating a more comprehensive photographic food atlas for all adolescents in Kenya as a whole. A similar protocol as to that used in this study can be used in designing a photographic food atlas for different age groups, such as adults and younger children. To improve the robustness of the atlas, there should be more portion size measurements, or even a nationwide food intake survey to determine the most common foods and average portion sizes.

This would allow the portion sizes to range from the 5th to the 95th centile as recommended by Nelson & Haraldsdóttir (13) and the number of portion sizes could be 3-6. The sample of the food intake survey should include the highest and lowest socioeconomic groups as well as the food culture of different religions, ethnicities, tribes and regions including food consumed in rural areas. Something of note is that Foster et al. (28), included very small portion sizes in the atlas for children and adolescents to be used for estimating leftovers. Their findings were that children left over 26% of their portion, which is a substantial amount when assessing dietary intake. The portion size range for leftovers were seven weights down from the 5th centile to the smallest representable portion. These are the recommended next steps in order to ensure a validated and accurate photographic food atlas for quantifying dietary intake in the Kenyan context.

7 Conclusions

The aim of this study was to develop a photographic food atlas for 9-14-year-olds in Nairobi and test its usability. The literature was reviewed in order to understand how to develop a photographic food atlas and what may affect its usability and validity. A photographic food atlas consisting of 88 foods was developed based on triangulation of literature sources, expert knowledge and collected quantitative and qualitative data. The usability of the atlas was tested among both adolescents and Kenyan nutrition professionals.

Overall, the atlas was well received amongst adolescents and nutrition professionals as indicated by the average usability scores classified as "OK" and "Good". Verbal feedback collected from adolescents and professionals was used to corroborate their answers from the usability survey and highlight issues that were not apparent from the usability survey. The adolescents reported that it aided them in the portion size estimation, though they felt they could not use it alone. All professionals also agreed they would use it in their research after some modifications. Adolescents and professionals agreed that most of the commonly consumed foods amongst 9-14-year-old Nairobi children were included, however there was uncertainty around the adequacy of large and especially small portion sizes. The poor quality of pictures and inaccurate portion sizes of the first version of the atlas hampered usability.

A second version of the photographic food atlas was created based on the usability survey feedback from the adolescents and nutrition professionals. An additional 83 foods were added to the second version as well as more portion sizes for some foods. The portion sizes were photographed again using better lighting and positioning of foods. The food habits of ages 9-14 years, both genders and low- and middle-SES in Nairobi were represented, but the highest and lowest socioeconomic groups and different ethnic and religious backgrounds were not all represented. The atlas has some limitations, as its development was only based on a small sample size and a limited number of weighings, resulting in a small portion size range.

The next step is to validate the photographic food atlas with the FFQ to understand how the photographs contribute to misclassification of subjects according to estimates of food consumption, or nutrient intake. The validation should include a sample of 9-14-year-olds from Nairobi from a low- and middle-socioeconomic status, but could also include adolescents of a wider age range, from different urban areas within Kenya and a wider range of SES. This would provide an understanding of whom the photographs are appropriate (or inappropriate) for and allow the formulation of correction factors to be used in dietary assessment.

This atlas is the first of its kind in Kenya to be based on actual weighed portion sizes and thus is a unique tool, especially considering the lack of national level data on dietary intake amongst adolescents in Kenya. The qualitative research completed in the community has ensured that it is a culture-specific and relevant tool. The atlas has been used in the cross-sectional KENFIN-EDURA study of 150 adolescents in Nairobi and has been distributed to other universities within Kenya as well as the Kenyan Ministry of Health and various non-governmental organisations including UNICEF and WHO.

There has been a lack of tools adapted to Kenyan and African settings for quantifying dietary intake. The ambition is that this atlas will be taken up as a tool by Kenyan nutrition professionals and incorporated into research, counselling and community work. In addition, the fact that it is in both English and Kiswahili makes it even more accessible to all people. The hope is that with this tool it will be possible to obtain more data on the dietary intake and habits of adolescents in the rapidly changing urban areas of countries transitioning from LMICs. The process and lessons learnt from developing a photographic food atlas reported here can also serve as a reference point for the development of more photographic food atlases for different age and ethnic groups and areas within other sub-Saharan African countries as well as in other LMICs.

Literature

1. Organisation for Economic Co-operation and Development (OECD). Development Assistance Committee (DAC) List of Official Development Assistance (ODA) Recipients [Internet]. [cited 2020 Mar 16]. Available from: http://www.oecd.org/dac/financing-sustainable-development/development-finance-standards/daclist.htm

2. The World Bank. Kenya Among the Fastest Growing Economies in Africa [Internet]. 2015 [cited 2020 Mar 16]. Available from: https://www.worldbank.org/en/news/press-release/2015/03/05/kenya-among-the-fastest-growing-economies-in-africa

3. Kimani-Murage EW, Muthuri SK, Oti SO, Mutua MK, van de Vijver S, Kyobutungi C. Evidence of a Double Burden of Malnutrition in Urban Poor Settings in Nairobi, Kenya. PLoS ONE. 2015;10(6):e0129943.

4. Kenya Ministry of Health. National Guidelines for Health Diets and Physical Activity [Internet]. Nairobi: Government of Kenya; 2017. Available from: http://www.fao.org/nutrition/education/food-dietary-guidelines/regions/countries/kenya/en/

5. Onyango EM, Onyango BM. The Rise of Noncommunicable Diseases in Kenya: An Examination of the Time Trends and Contribution of the Changes in Diet and Physical Inactivity. J Epidemiol Glob Health. 2018;8(1–2):1–7.

6. Passmore R, Nicol BM, Narayana Rao M. Handbook on Human Nutritional Requirements. Italy: Food and Agriculture organization of the United Nations and World Health Organization; 1974.

7. Ochola S, Masibo PK. Dietary intake of schoolchildren and adolescents in developing countries. Ann Nutr Metab. 2014;64 Suppl 2:24–40.

8. Francis DK, Van den Broeck J, Younger N, McFarlane S, Rudder K, Gordon-Strachan G, et al. Fast-food and sweetened beverage consumption: association with overweight and high waist circumference in adolescents. Public Health Nutr. 2009 Aug;12(8):1106–14.

9. Dodd KW, Guenther PM, Freedman LS, Subar AF, Kipnis V, Midthune D, et al. Statistical methods for estimating usual intake of nutrients and foods: a review of the theory. J Am Diet Assoc. 2006 Oct;106(10):1640–50.

10. Wolper C, Heshka S, Heymsfield S. Measuring food intake: An Overview. In: Handbook of assessment methods for eating behaviors and weight-related problems: Measures, theory, and research. Thousand Oaks, CA, US: Sage Publications, Inc; p. 215–40.

11. Livingstone MB, Robson PJ. Measurement of dietary intake in children. Proc Nutr Soc. 2000 May;59(2):279–93.

12. Foster E, Matthews JNS, Nelson M, Harris JM, Mathers JC, Adamson AJ. Accuracy of estimates of food portion size using food photographs--the importance of using age-appropriate tools. Public Health Nutr. 2006 Jun;9(4):509–14.

13. Nelson M, Haraldsdóttir J. Food photographs: practical guidelines II. Development and use of photographic atlases for assessing food portion size. Public Health Nutr. 1998 Dec;1(4):231–7.

14. Haapa E, Toponen T, Pietinen P, Räsänen L. Annoskuvakirja (portion picture booklet). National Public Health Institute and the Department of Nutrition, University of Helsinki; 1985.

15. Nelson M, Atkinson M, Meyer J. A photographic atlas of food portion sizes. Ministry of Agriculture, Fisheries and Food; 1997.

16. Hercberg S, Deheeger M, Preziosi P. Portions Alimentaires. Manuel photos pour I'estimation des quantités. Institut Scientifique et Technique de la Nutrition et de I'Alimentation, Conservatoire National des Arts et Métiers, CNAM Paris. Candia Polytechnica, France; 1994.

17. Amougou N, Cohen E, Mbala ML, Grosdidier B, Bernard JY, Saïd-Mohamed R, et al. Development and validation of two food portion photograph books to assess dietary intake among adults and children in Central Africa. Br J Nutr. 2016 Mar 14;115(5):895–902.

18. Venter CS, MacIntyre UE, Vorster HH. The development and testing of a food portion photograph book for use in an African population. J Hum Nutr Diet. 2000 Jun;13(3):205–18.

19. Tueni M, Mounayar A, Birlouez-Aragon I. Development and evaluation of a photographic atlas as a tool for dietary assessment studies in Middle East cultures. Public Health Nutr. 2012 Jun;15(6):1023–8.

20. Bouchoucha M, Akrout M, Bellali H, Bouchoucha R, Tarhouni F, Mansour AB, et al. Development and validation of a food photography manual, as a tool for estimation of food portion size in epidemiological dietary surveys in Tunisia. Libyan J Med. 2016;11:32676.

21. Ali HI, Platat C, El Mesmoudi N, El Sadig M, Tewfik I. Evaluation of a photographic food atlas as a tool for quantifying food portion size in the United Arab Emirates. PLoS ONE. 2018;13(4):e0196389.

22. Harris-Fry H, Paudel P, Karn M, Mishra N, Thakur J, Paudel V, et al. Development and validation of a photographic food atlas for portion size assessment in the southern plains of Nepal. Public Health Nutr. 2016;19(14):2495–507.

23. Navarro A, Cristaldo PE, Díaz MP, Eynard AR. [Food photography atlas: its suitability for quantifying food and nutrient consumption in nutritional epidemiological research in Córdoba, Argentina]. Rev Fac Cien Med Univ Nac Cordoba. 2000;57(1):67–74.

24. Bernal-Orozco MF, Vizmanos-Lamotte B, Rodríguez-Rocha NP, Macedo-Ojeda G, Orozco-Valerio M, Rovillé-Sausse F, et al. Validation of a Mexican food photograph album as a tool to visually estimate food amounts in adolescents. Br J Nutr. 2013 Mar 14;109(5):944–52.

25. Turconi G, Guarcello M, Berzolari FG, Carolei A, Bazzano R, Roggi C. An evaluation of a colour food photography atlas as a tool for quantifying food portion size in epidemiological dietary surveys. Eur J Clin Nutr. 2005 Aug;59(8):923–31.

26. Lombard M, Steyn N, Burger H-M, Charlton K, Senekal M. A food photograph series for identifying portion sizes of culturally specific dishes in rural areas with high incidence of oesophageal cancer. Nutrients. 2013 Aug 6;5(8):3118–30.

27. Korkalo L, Erkkola M, Fidalgo L, Nevalainen J, Mutanen M. Food photographs in portion size estimation among adolescent Mozambican girls. Public Health Nutr. 2013 Sep;16(9):1558–64.

28. Foster E, Matthews JNS, Lloyd J, Marshall L, Mathers JC, Nelson M, et al. Children's estimates of food portion size: the development and evaluation of three portion size assessment tools for use with children. Br J Nutr. 2008 Jan;99(1):175–84.

29. Frobisher C, Maxwell SM. The estimation of food portion sizes: a comparison between using descriptions of portion sizes and a photographic food atlas by children and adults. J Hum Nutr Diet. 2003 Jun;16(3):181–8.

30. Vereecken C, Dohogne S, Covents M, Maes L. How accurate are adolescents in portion-size estimation using the computer tool Young Adolescents' Nutrition Assessment on Computer (YANA-C)? Br J Nutr. 2010 Jun;103(12):1844–50.

31. Thoradeniya T, de Silva A, Arambepola C, Atukorala S, Lanerolle P. Portion size estimation aids for Asian foods. J Hum Nutr Diet. 2012 Oct;25(5):497–504.

32. Brito AP, Guimarães CP, Pereira RA. Evaluation of photographs supporting an FFQ developed for adolescents. Public Health Nutr. 2014 Jan;17(1):139–44.

33. Nelson M, Atkinson M, Darbyshire S. Food photography. I: The perception of food portion size from photographs. Br J Nutr. 1994 Nov;72(5):649–63.

34. Biltoft-Jensen A, Holmgaard Nielsen T, Hess Ygil K, Christensen T, Fagt S. Accuracy of food photographs for quantifying food servings in a lunch meal setting among Danish children and adults. J Hum Nutr Diet. 2018;31(1):131–40.

35. Subar AF, Crafts J, Zimmerman TP, Wilson M, Mittl B, Islam NG, et al. Assessment of the accuracy of portion size reports using computer-based food photographs aids in the development of an automated self-administered 24-hour recall. J Am Diet Assoc. 2010 Jan;110(1):55–64.

36. Wrieden WL, Longbottom PJ, Adamson AJ, Ogston SA, Payne A, Haleem MA, et al. Estimation of typical food portion sizes for children of different ages in Great Britain. Br J Nutr. 2008 Jun;99(6):1344–53.

37. Foster E, O'Keeffe M, Matthews JNS, Mathers JC, Nelson M, Barton KL, et al. Children's estimates of food portion size: the effect of timing of dietary interview on the accuracy of children's portion size estimates. Br J Nutr. 2008 Jan;99(1):185–90.

38. Foster E, Hawkins A, Barton KL, Stamp E, Matthews JNS, Adamson AJ. Development of food photographs for use with children aged 18 months to 16 years: Comparison against weighed food diaries - The Young Person's Food Atlas (UK). PLoS ONE. 2017;12(2):e0169084.

39. Ovaskainen M-L, Paturi M, Reinivuo H, Hannila M-L, Sinkko H, Lehtisalo J, et al. Accuracy in the estimation of food servings against the portions in food photographs. Eur J Clin Nutr. 2008 May;62(5):674–81.

40. Foster E, Adamson AJ, Anderson AS, Barton KL, Wrieden WL. Estimation of portion size in children's dietary assessment: lessons learnt. Eur J Clin Nutr. 2009 Feb;63 Suppl 1:S45-49.

41. Lillegaard ITL, Overby NC, Andersen LF. Can children and adolescents use photographs of food to estimate portion sizes? Eur J Clin Nutr. 2005 Apr;59(4):611–7.

42. Nissinen K, Korkalo L, Vepsäläinen H, Mäkiranta P, Koivusilta L, Roos E, et al. Accuracy in the estimation of children's food portion sizes against a food picture book by parents and early educators. J Nutr Sci. 2018;7:e35.

43. Cameron M, Staveren WA van, editors. Manual on methodology for food consumption studies. Oxford [England] ; New York: Oxford University Press; 1988. 259 p.

44. Huybregts L, Roberfroid D, Lachat C, Van Camp J, Kolsteren P. Validity of photographs for food portion estimation in a rural West African setting. Public Health Nutr. 2008 Jun;11(6):581–7.

45. Lazarte CE, Encinas ME, Alegre C, Granfeldt Y. Validation of digital photographs, as a tool in 24-h recall, for the improvement of dietary assessment among rural populations in developing countries. Nutr J. 2012 Aug 29;11:61.

46. Naska A, Valanou E, Peppa E, Katsoulis M, Barbouni A, Trichopoulou A. Evaluation of a digital food photography atlas used as portion size measurement aid in dietary surveys in Greece. Public Health Nutr. 2016;19(13):2369–76.

47. Timon CM, Cooper SE, Barker ME, Astell AJ, Adlam T, Hwang F, et al. A Comparison of Food Portion Size Estimation by Older Adults, Young Adults and Nutritionists. J Nutr Health Aging. 2018;22(2):230–6.

48. Livingstone MB, Prentice AM, Coward WA, Strain JJ, Black AE, Davies PS, et al. Validation of estimates of energy intake by weighed dietary record and diet history in children and adolescents. Am J Clin Nutr. 1992 Jul;56(1):29–35.

49. United Nations Human Rights Office of the High Commissioner (OHCHR). Convention on the Rights of the Child [Internet]. 2002 [cited 2020 Mar 7]. Available from: https://www.ohchr.org/en/professionalinterest/pages/crc.aspx

50. World Health Organisation. Recognizing adolescence [Internet]. 2014 [cited 2020 Mar 7]. Available from: https://apps.who.int/adolescent/second-decade/section2/page1/recognizing-adolescence.html

51. Trolle E, Vandevijvere S, Ruprich J, Ege M, Dofková M, de Boer E, et al. Validation of a food quantification picture book targeting children of 0-10 years of age for pan-European and national dietary surveys. Br J Nutr. 2013 Dec;110(12):2298–308.

52. Nelson M, Atkinson M, Darbyshire S. Food photography II: use of food photographs for estimating portion size and the nutrient content of meals. Br J Nutr. 1996 Jul;76(1):31–49.

53. Nelson M, Haraldsdóttir J. Food photographs: practical guidelines I. Design and analysis of studies to validate portion size estimates. Public Health Nutr. 1998 Dec;1(4):219–30.

54. Lichtman SW, Pisarska K, Berman ER, Pestone M, Dowling H, Offenbacher E, et al. Discrepancy between self-reported and actual caloric intake and exercise in obese subjects. N Engl J Med. 1992 Dec 31;327(27):1893–8.

55. Namunwa K. Kenya leads Africa in Smartphone usage. Business Today Kenya [Internet]. 2019 Mar 11 [cited 2020 Mar 16]; Available from: https://businesstoday.co.ke/kenya-leads-africa-smartphone-usage/

56. Patton GC, Sawyer SM, Santelli JS, Ross DA, Afifi R, Allen NB, et al. Our future: a Lancet commission on adolescent health and wellbeing. Lancet. 2016 Jun 11;387(10036):2423–78.

57. Kenya National Bureau of Statistics (KNBS), Kenya Ministry of Health, National AIDS Control Council (NACC), National Council for Population and Development (NCPD), Kenya Medical Research Institute (KEMRI), The DHS Program, ICF International. 2014 Kenya Demographic and Health Survey (2014 KDHS) [Internet]. Nairobi; 2015 Dec. Available from: https://dhsprogram.com/pubs/pdf/fr308/fr308.pdf

58. World Health Organization. Nutrition Landscape Informaltion System (NLiS) Country Profile: Kenya [Internet]. 2020. Available from: https://apps.who.int/nutrition/landscape/report.aspx?iso=ken

59. Mwaniki EW, Makokha AN. Nutrition status and associated factors among children in public primary schools in Dagoretti, Nairobi, Kenya. Afr Health Sci. 2013 Mar;13(1):39–46.

60. Semproli S, Canducci E, Ricci E, Gualdi-Russo E. Nutrient intake in 5-17-year-old African boys and girls in a rural district of Kenya. Nutr Hosp. 2011 Aug;26(4):765–74.

61. Kenya Ministry of Health, Kenya National Bureau of Statistics (KNBS), World Health Organisation. Kenya STEPwise Survey for Non Communicable Diseases Risk Factors 2015 Report [Internet]. Nairobi; 2015 [cited 2020 Mar 7]. Available from: http://www.who.int/ncds/surveillance/steps/kenya/en/

62. Leenstra T, Petersen LT, Kariuki SK, Oloo AJ, Kager PA, ter Kuile FO. Prevalence and severity of malnutrition and age at menarche; cross-sectional studies in adolescent schoolgirls in western Kenya. Eur J Clin Nutr. 2005 Jan;59(1):41–8.

63. Murphy SP, Gewa C, Liang L-J, Grillenberger M, Bwibo NO, Neumann CG. School snacks containing animal source foods improve dietary quality for children in rural Kenya. J Nutr. 2003;133(11 Suppl 2):3950S-3956S.

64. Gewa CA, Murphy SP, Weiss RE, Neumann CG. Determining minimum food intake amounts for diet diversity scores to maximize associations with nutrient adequacy: an analysis of schoolchildren's diets in rural Kenya. Public Health Nutr. 2014 Dec;17(12):2667–73.

65. Masibo P. Effects of Initial Nutritional Status on the Responses to a School Feeding Programme among School Children Aged 6 to 13 Years in the Millennium Villages Project, Siaya, Kenya [Internet]. [South Africa]: Stellenbosch University; 2013. Available from: https://pdfs.semanticscholar.org/7fa6/2bc3bcc54ac919826dbd9948807593935d37.pdf

66. Kenya Ministry of Medical Services. Kenya National Clinical Nutrition and Dietetics Reference Manual. Government of Kenya; 2010 Feb. Report No.: First edition.

67. Ssewanyana D, Abubakar A, van Baar A, Mwangala PN, Newton CR. Perspectives on Underlying Factors for Unhealthy Diet and Sedentary Lifestyle of Adolescents at a Kenyan Coastal Setting. Front Public Health. 2018;6:11.

68. Tidemann-Andersen I, Acham H, Maage A, Malde MK. Iron and zinc content of selected foods in the diet of schoolchildren in Kumi district, east of Uganda: a cross-sectional study. Nutr J. 2011 Aug 9;10:81.

69. Doku D, Koivusilta L, Raisamo S, Rimpelä A. Socio-economic differences in adolescents' breakfast eating, fruit and vegetable consumption and physical activity in Ghana. Public Health Nutr. 2013 May;16(5):864–72.

70. Vila Real C, Pinto E, Maina NH. Fibrepro Project: Food Frequency Questionnaire. Unpublished. Correspondence via E-mail.

71. McLeod SA. Likert Scale [Internet]. Simply Psychology. 2019 [cited 2020 Feb 29]. Available from: https://www.simplypsychology.org/likert-scale.html

72. Bevan N, Carter J, Earthy J, Geis T, Harker S. New ISO Standards for Usability, Usability Reports and Usability Measures. In: Kurosu M, editor. Proceedings, Part I of the 18th International Conference on Human-Computer Interaction Theory, Design, Development and Practice. Springer International Publishing; 2016. p. 268–78.

73. Sauro J. Measuring Usability with the System Usability Scale (SUS) [Internet]. Measuring U. 2011 [cited 2020 Feb 29]. Available from: https://measuringu.com/sus/

74. U.S. Department of Health & Human Services. System Usability Scale (SUS) [Internet]. Usability.gov. 2020. Available from: https://www.usability.gov/how-to-and-tools/methods/system-usability-scale.html

75. Thomas N. How To Use The System Usability Scale (SUS) To Evaluate The Usability Of Your Website [Internet]. Usability Geek. 2015 [cited 2020 Feb 29]. Available from: https://usabilitygeek.com/how-to-use-the-system-usability-scale-sus-to-evaluate-the-usability-of-your-website/

76. UNICEF. Child development - Early Adolescent Years [Internet]. 2011 [cited 2020 Mar 7]. Available from: https://www.unicef.org/cwc/cwc_58622.html

77. Walsh H, Anono E, Okoth V, Clinton B, Mubasu D, Hyvönen A, et al. Photographic Food Atas - Kenya Adolescent (9-14 Years), 1st version [Internet]. The Kenya-Finland Education and Research Alliance (KENFIN-EDURA); 2018. Available from: https://kenfinedura.files.wordpress.com/2020/03/1st-version-photographic-food-atlas-30.07.2018-1.pdf

78. Lanerolle P, Thoradeniya T, de Silva A. Food models for portion size estimation of Asian foods. J Hum Nutr Diet. 2013 Aug;26(4):380–6.

79. Huybregts L, Roberfroid D, Lachat C, Van Camp J, Kolsteren P. Validity of photographs for food portion estimation in a rural West African setting. Public Health Nutr. 2008 Jun;11(6):581–7.

80. Mellor D, Moore KA. The use of Likert scales with children. J Pediatr Psychol. 2014 Apr;39(3):369–79.

81. Anono E, Walsh H, Kanerva N, Mubasu D, Okoth V, Clinton B, et al. Photographic Food Atlas for Kenyan Adolescents (9-14 years), 2nd version [Internet]. The Kenya-Finland Education and Research Alliance (KENFIN-EDURA); 2018. Available from: https://kenfinedura.files.wordpress.com/2020/03/photographic-food-atlas-2-2-11-2018-1.pdf

82. Alkerwi A, Vernier C, Sauvageot N, Crichton GE, Elias MF. Demographic and socioeconomic disparity in nutrition: application of a novel Correlated Component Regression approach. BMJ Open. 2015 May 11;5(5).

83. Di Noia J, Byrd-Bredbenner C. Determinants of fruit and vegetable intake in low-income children and adolescents. Nutr Rev. 2014 Sep;72(9):575–90.

84. Zarnowiecki DM, Dollman J, Parletta N. Associations between predictors of children's dietary intake and socioeconomic position: a systematic review of the literature. Obes Rev. 2014 May;15(5):375–91.

85. Katzmarzyk PT, Chaput J-P, Fogelholm M, Hu G, Maher C, Maia J, et al. International Study of Childhood Obesity, Lifestyle and the Environment (ISCOLE): Contributions to Understanding the Global Obesity Epidemic. Nutrients. 2019 Apr 15;11(4).

86. D'Haene E, Desiere S, D'Haese M, Verbeke W, Schoors K. Religion, Food Choices, and Demand Seasonality: Evidence from the Ethiopian Milk Market. Foods. 2019 May 16;8(5).

87. Kenya National Bureau of Statistics (KNBS), Society for International Development (SID) - East Africa. Exploring Kenya's Inequality: Pulling Apart or Pooling Together? [Internet]. Nairobi; 2013. Available from: http://inequalities.sidint.net/kenya/wp-content/uploads/sites/3/2013/10/Preliminary%20pages.pdf

88. Mwaniki EW, Makokha AN, Muttunga JN. Nutrition status and associated morbidity risk factors among orphanage and non-orphanage children in selected public primary schools within Dagoretti, Nairobi, Kenya. East Afr Med J. 2014 Sep;91(9):289–97.

89. Riang'a RM, Broerse J, Nangulu AK. Food beliefs and practices among the Kalenjin pregnant women in rural Uasin Gishu County, Kenya. J Ethnobiol Ethnomed. 2017 May 25;13(1):29.

90. Chege PM, Kimiywe JO, Ndungu ZW. Influence of culture on dietary practices of children under five years among Maasai pastoralists in Kajiado, Kenya. Int J Behav Nutr Phys Act. 2015 Oct 8;12:131.

91. Hansen AW, Christensen DL, Larsson MW, Eis J, Christensen T, Friis H, et al. Dietary patterns, food and macronutrient intakes among adults in three ethnic groups in rural Kenya. Public Health Nutr. 2011 Sep;14(9):1671–9.

92. Oniang'o RK, Komokoti A. Food habits in Kenya: the effects of change and attendant methodological problems. Appetite. 1999 Feb;32(1):93–6.

93. Lakhani SA, Jansen AA. Infant feeding practices among middle income urban Africans and Indians in Kenya. East Afr Med J. 1987 Feb;64(2):122–30.

94. Gelman R, Baillargeon R. A review of some Piagetian concepts. In: Handbook of Child Psychology: Cognitive Development. New York: Wiley; 1983. p. 167–230.

95. Apa Digital AG. Culture in Kenya [Internet]. Rough Guides. 2020 [cited 2019 Nov 13]. Available from: https://www.roughguides.com/destinations/africa/kenya/culture-etiquette/

96. Commisceo Global Consulting Ltd. Kenya - Language, Culture, Customs and Etiquette [Internet]. 2020 [cited 2019 Nov 13]. Available from: https://www.commisceo-global.com/resources/country-guides/kenya-guide

97. Food and Agriculture Organization of the United Nations, Kenya Ministry of Health, Kenya Ministry of Agriculture and Irrigation. Kenya Food Composition Tables [Internet]. 2018. Available from: http://www.fao.org/3/I8897EN/i8897en.pdf

98. Wiesmann U, Kiteme B, Mwangi Z. Socio-Economic Atlas of Kenya: Depicting the National Population Census by County and Sub-Location [Internet]. Nairobi: Kenya National Bureau of Statistics (KNBS); 2016. Available from: https://www.kenya-atlas.org/onlineatlas.html

99. The World Factbook. Africa: Kenya [Internet]. 2019. Available from: https://www.cia.gov/library/publications/the-world-factbook/geos/ke.html

100. Roser M, Ortiz-Ospina E. Literacy [Internet]. Our World in Data; 2016 Aug [cited 2020 Feb 26]. Available from: https://ourworldindata.org/literacy

101. Roser M, Ortiz-Ospina E. Global Education [Internet]. Our World in Data; 2016 Aug [cited 2020 Feb 26]. Available from: https://ourworldindata.org/global-education

102. Beasley LJ, Hackett AF, Maxwell SM, Stevenson L. The effect of a dietary preload on estimation of usual food portion size by photograph in female volunteers. J Hum Nutr Diet. 2004 Jun;17(3):219–25; quiz 227–30.

103. Robinson F, Morritz W, McGuiness P, Hackett A. A study of the use of a photographic food atlas to estimate served and self-served portion sizes. Journal of Human Nutrition and Dietetics. 1997;10:117–24.

Appendices

Appendix 1. Details on studies selected for the literature review including participants, study design and results of photographic food atlas validation studies.

Study	Study title	Participants and study setting	Atlas details	Study design	Results
Amougou et al., 2016 (17)	Development and validation of two food portion photograph books to assess dietary intake among adults and children in Central Africa.	Children aged 8-13 years, Cameroon (n=224) - parents estimated portion sizes of 3-7-year-olds - children's results compared to adults'	Paper atlas, 48 food items, 3 portion sizes (4 intermediary), age appropriate, photo size 75x100mm, angle 55°	Testing conceptualisation and memory. Mothers served out the meals which were weighed and consumed. Remaining food was weighed. After 24h, children were shown photographs and asked to report portion size. They were allowed to indicate smaller or larger portions than the images (4 intermediary portion sizes).	- 74% of the 556 portions tested were accurately estimated - no differences between the sexes - small- and medium-sized portions were frequently selected and accurately estimated (>70%) - fish and leguminous food/meat were most frequently over estimated; cereal and sauce was most frequently underestimated - adults were likely to overestimate, whereas children were likely to underestimate - findings suggest that the children's atlas can be used in Cameroon to estimate food portion sizes
Bernal-Orozco et al., 2012 (24)	Validation of a Mexican food photograph album as a tool to visually estimate food amounts in adolescents.	Adolescents aged 14-19 years, Mexico (n=463)	Paper atlas, 163 food items, 4 portion sizes (descending order, 4 intermediary), age appropriate, photo size 41x61mm, angle 45°	Testing perception. Two portion sizes (one equal to picture, one between picture weights) were displayed and children were asked to estimate with atlas, measuring cups and food models.	- the best estimate was made using the atlas, as occurred in sixty-eight instances (65,4%) - the lowest mean error occurred when using the atlas - the atlas had lowest estimation error: average error 2,3% - although differences between estimated and real weight were statistically significant for almost all foods, comparisons between methods showed the atlas to be the most accurate tool for estimating food amounts
Biltoft-Jensen et al., 2018 (34)	Accuracy of food photographs for quantifying food servings in a lunch meal setting among Danish children and adults.	Children aged 8-12 years, Denmark (n=109) - children's results compared to adults'	Photographs, 37 food items, 6 portion sizes, not age appropriate, photo size 90x60mm, angle 52° for casseroles etc., 25° for spreads; and 35° degrees for cake	Testing perception. Children self-served at canteen/had packed lunch boxes. The children were asked to determine which photograph in the series corresponded best to the portion after which the portions were weighed. Allowed to choose fractions of a photograph portion or more than one photograph within a photographic series.	- the proportion of correct estimations was 42% overall (range 19–77%) - children, in just as many cases as adults, chose the correct photograph - children more likely have larger positive estimation errors whereas adults have negative estimation errors - macronutrient content based on the children's lunch showed much larger overestimations than for adults - in a real-life situation the photographs show an inaccuracy compared to the actual weights
Brito et al., 2012 (32)	Evaluation of photographs supporting an FFQ developed for adolescents.	Children and adolescents aged 11-18 years, Brazil (n=62)	Paper photographs, 95 food items, 3 portion sizes, age appropriate	Testing perception. Three portion sizes were presented, one of which was equal to the one shown in the photograph. Children were asked to identify which actual portion was identical to the portion size in the picture.	- at least 90 % of adolescents correctly identified the food in ninety-two photographs and the food in the three remaining photographs was recognized by 80–89 % of the adolescents - at least 98% of adolescents correctly identified eleven portion sizes, 70% correctly identified the portion sizes of 31 foods, 50-69% correctly recognised the portion size of 8 foods, and less than 50% recognised the portion size of 4 foods - the photographs are an appropriate visual aid for reporting the food consumption by adults

Study	Study title	Participants and study setting	Atlas details	Study design	Results
Foster et al., 2006 (12)	Accuracy of estimates of food portion size using food photographs--the importance of using age-appropriate tools.	Children aged 4-11 years, UK (n=210) - children's results compared to adults'	Photographs, 16 food items, 7 portion sizes, age appropriate (four sets for different age groups) and adult portion sizes	Testing perception, conceptualisation and memory. Children were shown plates containing foods of known weights. The children were asked to estimate the amount of food on the plate using food photographs designed for adults and for children. Estimates were made with food in front of them or 24h after being shown the food. Allowed to choose intermediary sizes. Served portion sizes that did not exactly match those in the photographs.	- children's estimates of portions were significantly more accurate using age-appropriate food photos (1% underestimation on average) than when using adult portion photos (45% overestimation on average) - accuracy of children's estimates using age appropriate photographs was not significantly different from adults - children overestimated a food's weight by 18% on average and adults underestimated by 5% by average - providing children with age-appropriate photographs of portion sizes greatly increases the accuracy of portion size estimates compared to using adult portion sizes
Foster et al., 2008 (28)	Children's estimates of food portion size: the development and evaluation of three portion size assessment tools for use with children	Children and adolescents aged 4-16 years, UK (n=201)	Photographs (food models and interactive portion size assessment system (IPSAS)), 7 portion sizes, age appropriate (four sets for different age groups)	Testing perception, conceptualisation and memory. Children were asked to evaluate food portions served and the leftovers with food photographs, food models and an IPSAS. Served portion sizes did not exactly match any of those depicted in the portion size assessment aids. Estimates were made 24h after eating the foods.	- children of all ages performed well using the IPSAS and food photographs, whereas the accuracy and precision of estimates made with the food models were poor - children underestimated by 4% on average when using IPSAS and overestimated by 7% on average when using the photographs - for all tools estimates of the amount of food served were more accurate than he amount consumed - both accuracy and precision improved with age for all methods for estimates of amounts of food served and consumed - food photographs were only slightly less accurate than the IPSAS and may be more usable in the field
Foster et al., 2008 (37)	Children's estimates of food portion size: the effect of timing of dietary interview on the accuracy of children's portion size estimates	Children aged 4-14 years, UK (n=108)	Photographs (food models and IPSAS), 12 food items, 7 portion sizes, age-appropriate	Testing perception, conceptualisation and memory. Children were asked to evaluate the food portion sizes served for them with the different methods with the food in front of them, just after they had eaten and 24h after they had eaten.	- children of all ages performed well using the IPSAS and food photographs - no significant differences in children's abilities to estimate portion size with timing of interview – children were as accurate in their estimations 24h after consumption as they were when the food was in view - precision and accuracy improve with age - at least at a group level, children are able to estimate food portion size utilising perception, conceptualisation and memory skills although ability varied both across and within each age group
Foster et al., 2017 (38)	Development of food photographs for use with children aged 18 months to 16 years: Comparison against weighed food diaries - The Young Person's Food Atlas (UK).	Children and adolescents aged 1.5-16 years, UK (n=313) - parents estimated portion sizes of 1.5-4-year-olds	Paper atlas, 104 food items, 7 portion sizes, age appropriate	Testing conceptualisation and memory. Children's parents were asked to keep a weighed 4-day food diary. After the diary ended children were asked to estimate the amount of foods served using the atlas. For children of school-age (over 4 years) both child and parent were interviewed.	- mean estimates of portion size consumed were within 7% of the weight of food recorded in the weighed food diaries - good agreement between the food atlas and weighed food diaries a the group level, but high variability at the individual level though precision increased with age - for children 11 years and over, agreement with weighed food diaries, was as good as that of their parents for total weight of food consumed and intake of energy and key nutrients - age appropriate food photographs offer an alternative to weighed intakes for dietary assessment with children

Study	Study title	Participants and study setting	Atlas details	Study design	Results
Frobisher & Maxwell, 2003 (29)	The estimation of food portion sizes: a comparison between using descriptions of portion sizes and a photographic food atlas by children and adults.	Children adolescents aged 6-16 years, UK (n=37) - children's results compared to adults'	Atlas, 9 food items, 8 portion sizes, not age appropriate	Testing conceptualisation and memory. Each subject served themselves their normal portion of the 9 food items. Weight was recorded and foods were removed. The subjects were asked to describe their portions with the words *small*, *medium* or *large* and asked to choose one of the photographs from the food photographic atlas, which best represented theirs. Subjects were called 3-4 days later to recall size of foods served.	- substantial differences in the estimate of portion sizes were observed for most foods regardless of the method used or age of the subjects - the median percentage difference range at the initial testing period was -52 to 79% for children at the initial testing periods and -52 to 100% 3-4 days after - the median percentage differences were greater for the children compared to adults - there was hardly any difference in accuracy of portion estimation between the two testing periods
Korkalo et al., 2013 (27)	Food photographs in portion size estimation among adolescent Mozambican girls.	Girls aged 13-18 years, Mozambique (n=99)	Paper photographs, 5 food items, 3 portion sizes, age appropriate, life-size pictures, angle 45°	Testing conceptualisation. Participants ate weighed portions of one staple food and one sauce. After the meal, they were asked to estimate the amount of food with the aid of the food photographs. The participants were allowed to describe their portion freely, by indicating the correct photograph or for example showing from the photograph which part of the portion they consumed.	- the mean differences between estimated and actual portion sizes ranged from -19 to 8% for different foods - for the staple foods, between 62 and 64% of the participants were classified into the same thirds of the distribution of estimated and actual food consumption - there was no significant differences in the proportions of participants between the estimate categories for staple foods or sauces with regard to age or school attendance - small portions were often correctly estimated; especially larger portions tended to be underestimated - the variation in accuracy of individual estimates was large, however, ability to rank individuals according to consumption was satisfactory for most foods
Lillegaard et al., 2005 (41)	Can children and adolescents use photographs of food to estimate portion sizes?	Children and adolescents aged 9-19 years, Norway (n=63)	Paper atlas, 12 food items, 4 portion sizes, age appropriate, picture size 50x65mm, angle 42˚	Testing perception. Participants were presented pre-cooked and weighed portion sizes and asked to note down which photograph in the atlas corresponded to that on the plate. Foods were not consumed. Participants were presented 17 foods – 5 were not depicted in booklet, but other food item portion sizes were used). Portion sizes were equal to the pictures or 1/3 above or below portion sizes depicted.	- on average, 60% of comparisons were made correctly – the correct photo was picked - a photograph directly adjacent to the photograph depicting the correct portion size was chosen in 35% of the comparisons and 5% of comparisons were made incorrectly - portion sizes were estimated more accurately when the actual served portions of food looked the same as the foods in the atlas - there were no differences between children and adolescents' abilities to estimate portion size - large variability existed between individuals but the error at group level was small

Study	Study title	Participants and study setting	Atlas details	Study design	Results
Thoradeniya et al., 2012 (31)	Portion size estimation aids for Asian foods.	Children and adolescents aged 10-16 years, Sri Lanka (n=80)	Photographs (household utensils and line diagrams), 16 food items, 3 portion sizes, age appropriate, two picture sizes 130x180mm and 200x300mm (life-size), angle: directly from above	Testing conceptualisation. Food portions were served and shown for 20 seconds and then hidden. The estimation aid was shown and the response was recorded. Four rounds for the four different aids (small photos, life-size photos, hh utensils and line diagrams). The children were not allowed to select in-between sizes but were asked to select small medium or large only.	- using life-size photographs resulted in 57% correct estimations, small photographs in 48.3% correct estimations whereas line diagrams resulted in 63.9% correct estimations - over and under estimations were also low for line diagrams (around 18%) - correct estimations were extremely low for household utensils - greater accuracy and precision was obtained for amorphous foods with small photographs - food texture, but neither age or sex, were associated with correct estimations - a combination estimation aid (with line diagrams and small photographs) produced best accuracy and precision
Turconi et al., 2005 (25)	An evaluation of a colour food photography atlas as a tool for quantifying food portion size in epidemiological dietary surveys.	Participants aged 6-60 years, Italy (n=448) - all analyses carried out for the entire age group, but age was taken into account in analyses	Paper atlas, 434 food items, 3 portion sizes, not age appropriate, picture size 90x85mm, angle 45°	Testing conceptualisation. People served themselves in a cafeteria, foods were weighed after which people ate the food. 5-10 minutes after eating food they were asked to estimate the size of their portion using the atlas. They were also allowed to pick 4 virtual portion sizes.	- weights of portion sizes indicated in the photographs are significantly associated to weights of eaten portions and are independent of age, gender and BMI - the differences between mean weights of the portions chosen and mean weights of eaten foods are significant for all food categories except for bread, but mean differences were very small due to large number of observations - use of three photographs and virtual portion sizes was associated with relatively small errors
Vereecken et al., 2010 (30)	How accurate are adolescents in portion-size estimation using the computer tool Young Adolescents' Nutrition Assessment on Computer (YANA-C)?	Adolescents aged 11-17 years, Belgium (n=128)	Digital photos (YANA-C), 10 food items, 9 portion sizes, not sure whether age appropriate	Testing perception and conceptualisation. 1st approach: Adolescents were asked to serve themselves normal portions, which were weighed and then they chose the equivalent portion from the YANA-C tool. 2nd approach: Different portion sizes presented simultaneously. In both cases, in-between amounts were also accepted.	- self-served potions were underestimated by 8% on average, with significant underestimates for breakfast cereals, French fries, peas and carrots - on average 21% of the estimates were within 10% of the self-served weight, 51% of the estimates were within 25% of the self-served weights and 84% within 50% - the correct photograph was selected by 31%, on average, whereas the correct or an adjacent photograph was chosen by 71% on average - pre-weighed portions were underestimated by 15% on average, with significant underestimates for fourteen foods out of twenty portions - photographs can serve as a good aid in ranking subjects, but to assess actual intake at group level, underestimation must be considered

Appendix 2. Study information form in English.

KENFIN-EDURA 7.7.2018

INFORMATION ON KENFIN-EDURA RESEARCH

The Kenya-Finland Education and Research Alliance (KENFIN-EDURA) is a collaborative project between Kenyatta University, Kenya and the University of Helsinki, Finland aiming on building higher education and research capacity to address the physical activity and nutrition transition in Kenya. A part of this collaboration is research that will look at explaining non-communicable disease related behavior in Nairobi in the context of family and poverty.

This is a small-scale pilot study part of KENFIN-EDURA that will be looking at 9-14-year old's nutrition. The research will be investigating the most commonly eaten foods and most common portion sizes amongst urban adolescents in Nairobi. Based on the most common foods and portion sizes found, a photographic food atlas will be made to be used in future nutrition studies including future KENFIN-EDURA research. The usability of the photographic food atlas will be tested during this study.

What we wish to do is come into 10 households and observe lunch times. During the first visit we will note down recipes of the foods cooked and weigh the portion sizes the children eat. During a second visit we will ask 5 women to cook food for us and pictures will be taken of the portions cooked. The space, food and cooking utensils will be provided. **During a third visit, 10 adolescents from different households will be asked to fill in a questionnaire on their diet (Food Frequency Questionnaire) with the help of the researcher. They will be able to use the photographic food atlas as support in estimating portion sizes. The children will then be asked a set of questions about the usability of the photographic food atlas.**

Data collected from the participants will be kept confidential and only be used for the purpose of the research. Participant data will also be anonymous and names will be replaced with ID-numbers.

For further information please contact

DR.SOPHIE OCHOLA
KENYATTA UNIVERSITY
TELEPHONE NUMBER: 0721 449 803

Appendix 3. Study information form in Kiswahili.

KENFIN-EDURA 10.7.2019

TAARIFA KATIKA KENFIN-EDURA REARCH

Ushirikiano wa Elimu na Utafiti wa Kenya na Ufini (KENFIN-EDURA) ni mradi wa ushirikiano kati ya Chuo Kikuu cha Kenyatta, Kenya na Chuo Kikuu cha Helsinki, Finland yenye lengo la kujenga elimu ya juu na uwezo wa utafiti wa kukabiliana na shughuli za kimwili na mabadiliko ya chakula nchini Kenya. Sehemu ya ushirikiano huu ni utafiti ambao utaangalia kuelezea tabia isiyohusiana na magonjwa yanayohusiana na ugonjwa huko Nairobi katika mazingira ya familia na umaskini.

Hii ni sehemu ndogo ya utafiti wa majaribio ya KENFIN-EDURA ambayo itaangalia lishe ya umri wa miaka 9-14. Utafiti huo utafuatilia vyakula vinavyotumiwa kwa kawaida zaidi na ukubwa wa kawaida kati ya vijana wa mijini huko Nairobi. Kulingana na vyakula vya kawaida na ukubwa wa sehemu zilizopatikana, athari ya picha ya picha itafanyika kutumika katika masomo ya lishe ya baadaye ikiwa ni pamoja na utafiti wa KENFIN-EDURA ujao. Usability wa atlas ya chakula picha itakuwa kupimwa wakati wa utafiti huu.

Tunachotaka kufanya ni kuja katika nyumba 10 na kuchunguza nyakati za chakula cha mchana. Wakati wa ziara ya kwanza tutaangalia chini mapishi ya vyakula kupikwa na uzito wa ukubwa wa sehemu watoto wanala. Wakati wa ziara ya pili tutauliza wanawake 5 kupika chakula na picha zitachukuliwa kwa sehemu zilizopikwa. Nafasi, chakula na vyombo vya kupika zitatolewa. Wakati wa ziara ya tatu vijana 10 kutoka kaya tofauti wataulizwa kujaza maswali katika chakula chao (Swala la Frequency Chakula) kwa msaada wa mtafiti. Watakuwa na uwezo wa kutumia atlas ya chakula ya picha kama msaada katika kupima ukubwa wa sehemu. Watoto wataulizwa seti ya maswali kuhusu usability wa atlas ya picha ya chakula.

Takwimu zilizokusanywa kutoka kwa washiriki zitashika siri na kutumika tu kwa kusudi la utafiti. Takwimu za washiriki pia zitajulikana na majina yatabadilishwa na nambari za ID.

Kwa habari zaidi tafadhali wasiliana

DR.SOPHIE OCHOLA
KENYATTA UNIVERSITY
Nambari ya simu: 0721 449 803

Appendix 4. Consent form in English.

KENFIN-EDURA 7.7.2018

CONSENT FORM FOR KENFIN-EDURA RESEARCH

Name of guardian & relation to child:

Name of child:

Date:

I give consent that my child or a child whom I am guardian of _____ (child's name) can participate in the KENFIN-EDURA study that will be looking at adolescent's nutrition. I was given a copy of the information below; I have read and understood what the research is about. I acknowledge that participation is voluntary, and I have the right to withdraw my child from the research at any given time without repercussions. All data collected will be kept confidential and anonymous.

Signature _____ Date & place _____

INFORMATION ON KENFIN-EDURA RESEARCH

The Kenya-Finland Education and Research Alliance (KENFIN-EDURA) is a collaborative project between Kenyatta University, Kenya and the University of Helsinki, Finland aiming on building higher education and research capacity to address the physical activity and nutrition transition in Kenya. A part of this collaboration is research that will look at explaining non-communicable disease related behavior in Nairobi in the context of family and poverty.

This is a small-scale pilot study part of KENFIN-EDURA that will be looking at 9-14-year old's nutrition. The research will be investigating the most commonly eaten foods and most common portion sizes amongst urban adolescents in Nairobi. Based on the most common foods and portion sizes found, a photographic food atlas will be made to be used in future nutrition studies including future KENFIN-EDURA research. The usability of the photographic food atlas will be tested during this study.

What we wish to do is come into 10 households and observe lunch times. During the first visit we will note down recipes of the foods cooked and weigh the portion sizes the children eat. During a second visit we will ask 5 women to cook food for us and pictures will be taken of the portions cooked. The space, food and cooking utensils will be provided. During a third visit 10 adolescents from different households will be asked to fill in a questionnaire on their diet (Food Frequency Questionnaire) with the help of the researcher. They will be able to use the photographic food atlas as support in estimating portion sizes. The children will then be asked a set of questions about the usability of the photographic food atlas.

Data collected from the participants will be kept confidential and only be used for the purpose of the research. Participant data will also be anonymous and names will be replaced with ID-numbers.

For further information please contact

DR.SOPHIE OCHOLA
KENYATTA UNIVERSITY
TELEPHONE NUMBER: 0721 449 803

Appendix 5. Consent form in Kiswahili.

KENFIN-EDURA 10.7.2018

FORM YA KUSA KWA KENFIN-EDURA REARCH

Jina la mlezi na uhusiano na mtoto:

Jina la mtoto:

Tarehe:

Ninatoa idhini kwamba mtoto wangu au mtoto ambaye ninayemwalinda _____ (jina la mtoto) anaweza kushiriki katika utafiti wa KENFIN-EDURA ambao utaangalia lishe ya vijana. Nilipewa nakala ya habari hapa chini; Nimesoma na kuelewa ni nini utafiti huo unahusu. Nakubali kwamba ushiriki ni wa hiari, na nina haki ya kumtoa mtoto wangu kutoka kwa utafiti wakati wowote bila matokeo. Takwimu zote zilizokusanywa zitahifadhiwa siri na haijulikani.

Saini _____ Tarehe & mahali _____

TAARIFA KATIKA KENFIN-EDURA REARCH

Ushirikiano wa Elimu na Utafiti wa Kenya na Ufini (KENFIN-EDURA) ni mradi wa ushirikiano kati ya Chuo Kikuu cha Kenyatta, Kenya na Chuo Kikuu cha Helsinki, Finland yenye lengo la kujenga elimu ya juu na uwezo wa utafiti wa kukabiliana na shughuli za kimwili na mabadiliko ya chakula nchini Kenya. Sehemu ya ushirikiano huu ni utafiti ambao utaangalia kuelezea tabia isiyohusiana na magonjwa yanayohusiana na ugonjwa huko Nairobi katika mazingira ya familia na umaskini.

Hii ni sehemu ndogo ya utafiti wa majaribio ya KENFIN-EDURA ambayo itaangalia lishe ya umri wa miaka 9-14. Utafiti huo utafuatilia vyakula vinavyotumiwa kwa kawaida zaidi na ukubwa wa kawaida kati ya vijana wa mijini huko Nairobi. Kulingana na vyakula vya kawaida na ukubwa wa sehemu zilizopatikana, athari ya picha ya picha itafanyika kutumika katika masomo ya lishe ya baadaye ikiwa ni pamoja na utafiti wa KENFIN-EDURA ujao. Usability wa atlas ya chakula picha itakuwa kupimwa wakati wa utafiti huu.

Tunachotaka kufanya ni kuja katika nyumba 10 na kuchunguza nyakati za chakula cha mchana. Wakati wa ziara ya kwanza tutaangalia chini mapishi ya vyakula kupikwa na uzito wa ukubwa wa sehemu watoto wanala. Wakati wa ziara ya pili tutauliza wanawake 5 kupika chakula na picha zitachukuliwa kwa sehemu zilizopikwa. Nafasi, chakula na vyombo vya kupika zitatolewa. Wakati wa ziara ya tatu vijana 10 kutoka kaya tofauti wataulizwa kujaza maswali katika chakula chao (Swala la Frequency Chakula) kwa msaada wa mtafiti. Watakuwa na uwezo wa kutumia atlas ya chakula ya picha kama msaada katika kupima ukubwa wa sehemu. Watoto wataulizwa seti ya maswali kuhusu usability wa atlas ya picha ya chakula.

Takwimu zilizokusanywa kutoka kwa washiriki zitashika siri na kutumika tu kwa kusudi la utafiti. Takwimu za washiriki pia zitajulikana na majina yatabadilishwa na nambari za ID.

Kwa habari zaidi tafadhali wasiliana

DR.SOPHIE OCHOLA
KENYATTA UNIVERSITY
Nambari ya simu: 0721 449 803

Appendix 6. Background information questionnaire.

KENFIN-EDURA 7.7.2018

BACKGROUND QUESTIONNAIRE

Child's name:

Address/phone number:

Date:

Birthdate:

Birthdate verified by:

a. Birth certificate
b. Recall
c. others

Gender:

Number of siblings:

Residential area:

a. Langata
b. Kayole

Education level/class in school:

Type of dwelling & material of the walls:

a. Permanent structure
b. Semi-permanent
c. Temporary

Father's highest level of education:

a. Primary
b. Secondary
c. Tertiary
d. University

Mother's highest level of education:

a. Primary
b. Secondary
c. Tertiary
d. University

Father's occupation

a. unemployed
b. casual labourer
c. small business
d. business
e. salary job

Mother's occupation:

a. unemployed
b. housewife
c. casual labourer
d. small business
e. business
f. salary job

Recording meals

Time of meal:

Which meal:

a. breakfast
b. lunch
c. dinner
d. other?

Who is serving the food:

a. mother
b. father
c. child themselves
d. other?

What food and drink did the adolescent have:

Name of food & drink	Portion size

Recipes & other notes

Appendix 7. The seven-day semi-quantitative food frequency questionnaire (FFQ).

KENFIN - EDURA

SEMI-QUANTITATIVE FOOD FREQUENCY QUESTIONNAIRE

Interviewer's Name _____

Name of child _____

The questionnaire aims to identify your food consumption during the previous month. So, for each food you should indicate how many times a day/week/month on average you ate each of the foods mentioned in this list, over the last month, and if the consumed quantity was smaller, equal or bigger to the correspondent standard portion.

	Frequency									Amount			
Food items	Never	1-3 per month	1 per week	2-4 times per week	5-6 times per week	1 per day	2-3 per day	4-6 per day	6+ per day	Standard	S	E	B
CEREALS AND GRAIN PRODUCTS (20 food items)													
Maize Ugali	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Millet Ugali	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Sorghum Ugali	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Mixed Ugali	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Maize Porridge	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Millet Porridge	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Sorghum Porridge	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Mixed Porridge	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
White Rice	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Brown Rice	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Maize (boiled, roasted)	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Spaghetti and macaroni	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Indomie (noodles)	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Weetabix wholegrain cereals	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Other type of breakfast cereals (chocorise, ricecrisps)	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
White Bread	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Wholegrain bread	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
White Chapatti	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐

Brown chapatti	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Pancake	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
TUBERS (7 food items)													
Irish potato (Boiled, stewed)	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Chips	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Potato (sweet)	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Cassava	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Matooke (plantain)	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Arrowroot	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Bhajia	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
VEGETABLES (27 food items)													
Carrots	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Pumpkin/butternut	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Sweet Pepper, Green Pepper	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Kales (Sukuma Wiki), cooked	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Cabbages, cooked	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Spinach, cooked	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
BlackNightShades (Managu), cooked	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Amaranthus (Terere), cooked	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Pumpkin leaves (Seveve, malenge leaves) , cooked	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Comfrey (Mabaki), cooked	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Bacella alba (Nderema), cooked	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Spider Weed(Sargiet), cooked	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Cowpeas Leaves	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Bean Leaves	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Jute Leaves (Mrenda), cooked	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
French Beans, cooked	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Green peas	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Courgettes	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Eggplant	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Okra	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Onions	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐

Tomatoes	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Garlic	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Mushrooms	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Cauliflower	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Broccoli	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Salad Vegetables (Lettuce, watercress)	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
LEGUMES, PULSES, SEEDS, AND NUTS (5 food items)													
Beans (e.g. soy, njahi)	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Lentils (Kamnde)	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Dried peas (e.g. cow, pigeon)	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Green Grams (Ndengu)	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Nuts, groundnuts and seeds (sesame, pumpkin, canola)	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
FRUITS (18 food items)													
Citrusfruits (orange, tangerine, lemon)	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Melon	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Grapes	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Passion fruit	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Pawpaw	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Apple	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Pears	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Guava	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Tree tomato	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Peaches	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Banana ripe	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Avocado	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Mangoes	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Luquarts	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Pineapple	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Plums	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Berries (strawberry)	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Wild berries	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
MEAT, FISH AND EGGS (20 food items)													
Beef	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐

Pork	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Chicken	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Other birds (turkey, ducks)	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Goat meat	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Lamb meat (mutton)	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Rabbit meat	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Game meat (rat)	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Processed meats (sausage, smokie)	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Offals (Matumbo)	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Other type of offals	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Organ meat (liver, heart, kidney, lungs, spline)	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Batter dippedfried chicken (e.g. KFC), kebab	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Omena (dried small fish)	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Tilapia	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Nile perch	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Othertypeoffish:tuna, sardines/pilchard, swordfish/marlin, mackerel, salmon, herring, etc.	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Canned fish	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Eggs (boiled, fried, scrambled)	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Insects (grass hoppers, termites)	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
DAIRY PRODUCTS (9 food items)													
Whole Milk (cow)	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Skimmed milk (cow)	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Goat milk	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Other types of milk (coconut, soya)	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Cream	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Cheese	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Yogurt	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Lala/Mala	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Milksubstitute(Mido, Cremora,SafariLand)	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
FATS AND OILS (9 food items)													

Butter	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Ghee	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Margarine (brick, tube)	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Cooking Fat (such as Kimbo, Kasuku)	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Sun flower oil	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Olive Oil	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Soybean Oil	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Corn Oil	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Other types of oil	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
SAUCES, SEASONINGS AND FLAVOURINGS (7 food items)													
Meat Extracts	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Savoury Spreads	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Sweet spreads (such as honey, jam, atchar)	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Tomato sauce	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Mayonese, Salad Dressing	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Spices and herbs (Royco)	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Peanut Butter	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
SUGAR, SYRUPS AND SWEETS (11 food items)													
Low sugar cookies, Rusks (such as Marie)	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
High-sugar cookies and biscuits	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Cakes, Tarts, Pudding	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Muffins/Scones, Pancakes/Waffles	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Mandazi or doughnuts	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Popcorn, Crips	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Ice cream	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Coloured ice (also with sugar)	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Candies	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Chocolates (snacks such as Mars, Snickers, Kit Kat, etc)	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Sugar (white, Brown)	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
BEVERAGES (11 food items)													
Carbonated Cold Drinks (Coca-cola, Fanta etc.)	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Diet cold drinks	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐

Energy drinks (RedBull, etc.)	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Coffee	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Tea	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Water	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Beer	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Wine	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Fruit Juices	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Sweetened Fruit- Flavoured Drinks (Quenche etc.)	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Milk Shakes	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
COMPOSITE DISHES (14 food items)													
Pilau	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Githeri	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Mukimo	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Biryiani	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Meat samosas	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Vegetable samosas	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Meat pies	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Pizza	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Beef burger	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Kachumbari	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Hotdog	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Sandwich (toastie)	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Rice & beans	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐
Rice & potatoes & carrots	☐	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐

In addition to the foods mentioned, there is something else that is part of your eating habits and I did not mention?

Appendix 8. Usability survey questionnaire for adolescents.

KENFIN-EDURA 30.7.2018

QUESTIONNAIRE ON USABILITY OF PHOTOGRAPHIC FOOD ATLAS CHILDREN

Name of child:

1. Did you like using the photographic food atlas?

YES NO

1.a. Why so?

2. The food atlas helped me with filling in the Food Frequency Questionnaire

1	2	3	4	5
Strongly disagree	Somewhat disagree	Neither agree/disagree	Somewhat agree	Strongly agree

3. The food atlas helped me remembering the portion sizes

1	2	3	4	5
Strongly disagree	Somewhat disagree	Neither agree/disagree	Somewhat agree	Strongly agree

4. The food atlas was easy to use

1	2	3	4	5
Strongly disagree	Somewhat disagree	Neither agree/disagree	Somewhat agree	Strongly agree

5. I would be able to use the food atlas by myself

1	2	3	4	5
Strongly disagree	Somewhat disagree	Neither agree/disagree	Somewhat agree	Strongly agree

6. The pictures in the food atlas are big enough

1	2	3	4	5
Strongly disagree	Somewhat disagree	Neither agree/disagree	Somewhat agree	Strongly agree

7. There are small enough portion sizes in the food atlas

1	2	3	4	5
Strongly disagree	Somewhat disagree	Neither agree/disagree	Somewhat agree	Strongly agree

7.a. If not, which foods need smaller portion sizes?

8. There are large enough portion sizes in the food atlas

1	2	3	4	5
Strongly disagree	Somewhat disagree	Neither agree/disagree	Somewhat agree	Strongly agree

8.a. If not, which foods need larger portion sizes?

9. I could recognise all the foods and drinks presented in the pictures

1	2	3	4	5
Strongly disagree	Somewhat disagree	Neither agree/disagree	Somewhat agree	Strongly agree

9.a. If not, which ones were unclear?

10. I could tell the difference between the different portion sizes

1	2	3	4	5
Strongly disagree	Somewhat disagree	Neither agree/disagree	Somewhat agree	Strongly agree

10.a. If not, which ones were unclear?

11. Are there any foods you normally eat that are missing?

YES NO

11.a. If yes, which ones?

12. Any other comments/feedback?

Appendix 9. Usability survey questionnaire for nutrition professionals.

KENFIN-EDURA 29.7.2018

QUESTIONNAIRE ON USABILITY OF PHOTOGRAPHIC FOOD ATLAS PROFESSIONALS

1. Profession (please circle)
    a. Researcher
    b. Nutritionist in the community
    c. Dietitian
    d. Other? _____
2. How many years you have been in the profession? _____

Please circle the appropriate number:

3. The portion sizes seem reasonable

1	2	3	4	5
Strongly disagree	Somewhat disagree	Neither agree/disagree	Somewhat agree	Strongly agree

3.a. If you disagree, which food's portion sizes don't seem reasonable?

4. There are enough portion sizes for each food

1	2	3	4	5
Strongly disagree	Somewhat disagree	Neither agree/disagree	Somewhat agree	Strongly agree

4.a. If you disagree, which foods should have more portion sizes?

5. There are small enough portion sizes in the food atlas

1	2	3	4	5
Strongly disagree	Somewhat disagree	Neither agree/disagree	Somewhat agree	Strongly agree

5.a. If not, which foods need smaller portion sizes?

6. There are large enough portion sizes in the food atlas

1	2	3	4	5
Strongly disagree	Somewhat disagree	Neither agree/disagree	Somewhat agree	Strongly agree

6.a. If not, which foods need larger portion sizes?

7. The pictures in the food atlas are big enough

1	2	3	4	5
Strongly disagree	Somewhat disagree	Neither agree/disagree	Somewhat agree	Strongly agree

8. I could recognise all the foods and drinks presented in the pictures

1	2	3	4	5
Strongly disagree	Somewhat disagree	Neither agree/disagree	Somewhat agree	Strongly agree

8.a. If you disagree, which ones could you not recognise?

9. The most commonly consumed foods by Kenyan adolescents in Nairobi are included

1	2	3	4	5
Strongly disagree	Somewhat disagree	Neither agree/disagree	Somewhat agree	Strongly agree

9.a. If you disagree, which foods are missing?

10. The order in which the foods are presented is logical

1	2	3	4	5
Strongly disagree	Somewhat disagree	Neither agree/disagree	Somewhat agree	Strongly agree

10.a. If you disagree, how would you change the order?

11. I would use this food atlas in my research/counselling

1	2	3	4	5
Strongly disagree	Somewhat disagree	Neither agree/disagree	Somewhat agree	Strongly agree

11.a. Why do you agree/disagree and what you would use it for?

Open questions

12. Should weights be presented…
    a. alongside pictures
    b. separately as an appendix
    c. or both?
13. Would it help to include a measure scale underneath pictures?

    YES NO

14. Have you previously used the South African photographic food atlas?

    YES NO

    14.a. If yes, what for?

15. Any other comments/feedback? Feel free to write anything that comes to mind!

Appendix 10. Foods and portion sizes of the first photographic food atlas.

Food number	Food	Portion A (g) 0.5 x B	Portion B (g) Average	Portion C (g) 1.5 x B
Cereals and grain products				
1.	Ugali	190	380	570
2.	Rice	102	204	306
3.	Chapati (homemade)		106	
4.	Pancake (homemade)		118	
5.	Uji porridge	330	328	347
6.	Bread	26	52	104
7.	Spaghetti	104	209	313
8.	Noodles (120g packet)		219	
9.	Cornflakes	21	42	63
10.	Weetabix &	20	40	60
	Milk	142	231	314
11.	Muesli	25	50	75
12.	Mandazi (market, triangle)	22	44	66
13.	KDF (market)	46	92	138
Tubers				
14.	Sweet potato (market)		323	
15.	Sweet potato small (homecooked)	48	96	192
16.	Chips (homemade)	60	120	180
17.	Chips (market)		80	
18.	Bhajia (market)	126	257	383
Vegetables				
19.	Pumpkin	88	103	151
20.	Cabbage	59	117	176
21.	Kales and spinach / Sukuma Wiki	70	140	210
22.	Traditional vegetables (for example, spider web leaves, cow pea leaves, amaranth, saga)	102	204	306
23.	Broccoli cauliflower, carrots	38	76	114
24.	Boiled maize	174	223	281
Legumes, pulses, seeds & nuts				
25.	Beans	73	145	218
26.	Green grams	69	138	206
Fruits				
27.	Banana (different sizes)	50	76	158
28.	Large banana without skin	42	83	135
29.	Small sweet bananas without skin	60	120	180
30.	Orange local (different sizes)	173	239	301
31.	Orange sweet South Africa	73	145	218
32.	Orange from supermarket with skin	96	191	287
33.	Apple (different sizes)	105	125	190
34.	Apple (medium)	63	125	188
35.	Mango (different sizes)	264	283	411
36.	Mango (local)		225	
37.	Mango without stone (large)	93	185	370
38.	Pineapple	80	160	240
39.	Watermelon		246	
40.	Avocado (different sizes)	170	366	467
41.	Avocado medium (without stone)	76	153	305
42.	Avocado small (without stone)	37	74	148
43.	Grapes	68	135	200

44.	Kiwi	42	83	125
45.	Peach (without stone)	82	164	246
Meat, fish & eggs				
46.	Beef stew	56	111	167
47.	Beef head (different sized pieces)	35	41	74
48.	Minced meat	73	147	220
49.	Goat stew	71	142	212
50.	Chicken stew	80	159	239
51.	Hot dog sausage	49	98	147
52.	Sausage	41	82	123
53.	Bacon	8	16	24
54.	Ham		25	
55.	Offal	50	100	150
56.	Omena	53	105	158
57.	Tilapia stew	91	183	274
58.	Fish fillet (nile perch)	31	62	93
59.	Scrambled egg	89	178	266
60.	Fried egg	50	100	150
61.	Boiled egg	56	21	35
Dairy products				
62.	Yoghurt	150	250	450
Spreads and sauces				
63.	Blue band	2	4	8
64.	Jam/honey	4	8	12
65.	Peanut butter/Nutella	5	10	15
66.	Ketchup	10	20	30
Sweets and snacks				
67.	Crisps	30	75	150
68.	Popcorn	25	50	75
69.	Lollipops	22	44	
70.	Queen cake	53	106	159
71.	Biscuit (4g)	21	42	63
Beverages				
72.	Tea (ceramic mug)	198	327	
73.	Tea (cream mug)	166	321	
74.	Fermented milk	152	304	
75.	Juice (ceramic mug)	105	200	341
76.	Juice (plastic cup)	77	165	243
Composite dishes				
77.	Githeri	100	200	300
78.	Pilau	81	162	243
79.	Kachumbari	41	82	124
80.	Rice and beans	286	572	858
81.	Rice, potato and carrots	193	385	578
82.	Mukimo	204	407	611
83.	Samosa	25	33	
84.	Sandwich	73	146	
85.	Hotdog		109	
86.	Beef burger (with cheese)		197	
87.	Pizza (medium)	70	210	420
88.	Pizza (large)	90	360	720

Appendix 11. Errors in the second (and first) version of the atlas.

Error	Page number in 2nd atlas	Implication	Recommendation
Mistake in labelling utensils: both a cup and bowl have been labelled portion size M.	6-7	It is not known whether the portion size referred to is the cup or the bowl.	Fix labelling in the next version of the atlas.
The utensils pictures was not given a number.	6-7	People using the atlas may not know that the utensils picture can also be utilised for portion size estimation	Use the picture number 0 to represent utensils pictures. Fix numbering in the next version of the atlas.
Portion sizes were not always rounded in the same way. In most cases the mean was calculated, then rounded, after which portion sizes A and C were calculated and also rounded if necessary. In the cases below though, portion sizes A and C were calculated from a mean value that had not been rounded and thus there are small errors in the way the portions have been rounded. [pic no in 1st atlas/pic no in 2nd atlas] 7./6. spaghetti 43./- grapes (different portion sizes used in 2nd atlas) 48./110. minced meat 57./114. tilapia stew 16./161. chips (homemade)	12 60 63 89 (not printed, see below)	The effect on portion size estimation accuracy should not be too significant as these are only small errors of 1-2 grams.	In the next version rounding should be done in a standard way. Rounding to the closest number dividable by five may also be considered.
Certain foods added to the 2nd version of the atlas, for example, fruits (93./98. grapes and 94. strawberries), meat dishes (102. liver, 104. gizzards and 108. stewed pork) and biscuits (124-129.) do not accurately follow the formula where B=average portion size, A=0.5xB and C=1.5xB. In most cases, the large portion size (C) was determined as the portion size bought from the street or supermarket. However, Kenyan nutrition students felt that the average (B) and small (A) portion sizes did not seem realistic when calculated with the formula used in this study and so adjusted the average (B) and small (A) portion sizes to reflect what they saw fit based on their observations in the field.	51-52 58, 60 71-73	Portion sizes are not based on actual weighed portions and thus may not be applicable to 9-14-year-olds.	Weighings of actual portion sizes of 9-14-year-olds should be carried out for the future versions and average portion sizes should be calculated according to the formula B=mean, A=0.5xB and C=1.5xB.
It was noticed in data analysis for the larger KENFIN-EDURA study, that the third, unlabelled picture of the boiled plantain (pic no 44) was often selected as a portion size C.	28	Initially, in the data analysis, all portion Cs of plantain were given the value 0, which would underestimate intake of both plantain and sweet bananas (as the picture of boiled plantain was also used to depict the larger sweet banana, see below).	If selected, the third, unlabelled picture, should be given the same value as portion B (97g). Portion sizes *between B and C*=B and *more than C*=1.5xB.
The portion sizes for beans (pic no 50) was calculated incorrectly and thus portion sizes depicted (A=73g, B=145g, C=218g) are not quite correct.	32	The atlas does not depict the accurate range of portion sizes for beans and this may affect estimation accuracy.	The correct portion sizes for beans would have been A=64g, B=127g, C=191g (range of weighed portions min=74g, max=194g). This can be fixed in the next version of the atlas.
Large sweet banana picture left out of 2nd version of atlas accidentally.	47	Food needs to be substituted with another picture instead and this can introduce an error.	Boiled plantain (pic no 44) or small sweet bananas (pic no 83) can be used instead. Include picture of banana into the next version of the atlas.

Error	Page number in 2nd atlas	Implication	Recommendation
The picture of peach (pic no 82) was still pixelated (hadn't been decompressed).	47	The pixelation may affect accurate perception of portion sizes.	The picture should be decompressed in the next version of the atlas.
The portion sizes for chicken stew (pic no 107) was calculated incorrectly and thus portion sizes depicted (A=80g, B=159g, C=239g) are not quite correct.	59	The atlas does not depict the accurate range of portion sizes for chicken stew and this may affect estimation accuracy.	The correct portion sizes for chicken stew would have been A=48g, B=96g, C=144g (range of weighed portions min=33g, max=159g). This can be fixed in the next version of the atlas.
Both small and big fried tilapia were under the picture number 114.	63	In analyses, it is unknown which tilapia size was actually selected. Some of the variation between participants' dietary intake will be lost.	The two different tilapia sizes should be given their own portion size numbers in the next version of the atlas.
Portion size A, which is one (1) creamy biscuit (pic no 131) is 49 grams. This is suspected to be incorrect.	74	The portion sizes of this biscuit will likely be overestimated if the incorrect value is used.	The biscuit weight should be fixed and corrected in the next version of the atlas.
The portion sizes for rice, carrot/pumpkin and potato mix (pic no 150) was calculated incorrectly and thus portion sizes depicted (A=193g, B=385g, C=579g) are not quite correct.	85	The atlas does not depict the accurate range of portion sizes for rice, carrot/pumpkin and potato mix and this may affect estimation accuracy.	The correct portion sizes for rice, carrot/pumpkin and potato mix would have been A=176g, B=351g, C=527g (range of weighed portions min=317g, max=385g). This can be fixed in the next version of the atlas.
Page 89 was printed blank so the pictures of chips (picture no 160 and 161) and *smokies* (Kenyan sausage) (picture no 162) are missing.	89	Food needs to be substituted with another picture instead and this can introduce an error.	*Bhajia* (pic no 168) and coloured potatoes (pic no 169) can be used instead. Include pictures of chips and smokies into the next version of the atlas.
Both green gram and potato filled samosas (pic no 167) were depicted in portion size A.	91	In analyses, it is unknown which samosa was actually selected or whether participants thought portion size A consisted of two samosas. Some of the variation between participants' food intake will be lost.	The different samosas should all be clearly labelled with their own portion size in the next version of the atlas.
Nyama choma was not included in the atlas, though it is a commonly consumed food in Kenya.	-	Food needs to be substituted with another picture instead and this can introduce an error.	The pictures of meat can be used instead. Include picture of *nyama choma* into the next version of the atlas.
No reference object, such as spoon, was included into the pictures.	-	This may hinder accurate perception of portion sizes from the photographs.	If pictures are retaken, it is recommended to add a spoon as a reference object. Alternatively, when using the atlas, the plate in the pictures could be given to the participants.
Oversaturation of colours.	-	The inaccurate colours may hinder recognition of foods as well as affect accurate perception of portion sizes.	When printing the next version, special attention should be payed to the accuracy of the colours of the foods.
After printing of the 2nd version of the atlas, it was decided that more detailed instructions of use should be developed.	-	Users of the atlas should be well trained before using the atlas as a tool for quantitative dietary intake measurement or counselling.	More detailed instructions of use for different purposes are being written and they should be included in the next version of the atlas and distributed with the 2nd version.

Appendix 12. Foods and portion sizes of the second photographic food atlas.

Food number	Food	Portion A (g) 0.5 x B	Portion B (g) Average	Portion C (g) 1.5 x B
Cereals and cereal products				
1	Maize ugali	190	380	570
2	Mixed flour ugali/millet/sorghum	134	240	370
3	Maize porridge	347		
4	Mixed porridge/millet porridge/sorghum porridge	330	328	347
5	Boiled white rice	102	204	306
6	Spaghetti	104	209	313
7	Macaroni	103	164	232
8	Fusilli	131	232	354
9	Noodles	219	438	657
10	Sesame bun	66		
11	Weetabix	20	40	60
12	Corn flakes	21	42	63
13	Muesli	25	50	75
14	Whole grain cereal biscuits	36	53	71
15	Oat porridge	128	270	406
16	White bread/sweet yellow bread - 600g pkt	27	54	81
17	White bread/sweet yellow bread - 400g pkt	26	52	104
18	White bread/sweet yellow bread - 800g pkt	37	74	111
19	Brown bread - 400g	26	52	104
20	Barrel bread	50	75	100
21	Whole grain bread - 600g pkt	33	66	99
22	Scones	32	72	103
23	Small Bites (1pkt)	50	99	199
24	Round mandazi/kaimati	60	120	180
25	Squared mandazi - supermarket	62	124	186
26	Triangular mandazi - supermarket	94	188	282
27	Mandazi - street/ locally made	144	288	432
28	KDF	103		
29	Tea scone	141	282	423
30	Round doughnut	126		
31	Round doughnut with chocolate topping	151		
32	Elongated doughnut with cream filling	140		
33	Pancake - Home- made	71		
34	Pancake - Super- market	175		
35	White chapati - homemade	107		
36	White chapati - supermarket	139		
37	Brown chapati - homemade	113		
38	Brown chapati - supermarket	133		
39	Pumpkin chapati	149		
40	Roasted maize without cob	148	296	444
41	Boiled maize	246	303	455
Starchy roots, bananas and tubers				
42	Boiled butternut squash	205	243	
43	Boiled pumpkin	99	204	
44	Boiled plantain	53	97	
45	Boiled Irish potato	60	102	249

46	Stewed plantain/ green bananas	211	359	615
47	Boiled sweet potato	214	239	454
48	Boiled cassava	67	118	261
49	Boiled arrowroot	232	263	267
Legumes, pulses, nuts and seeds				
50	Stewed beans	73	145	218
51	Stewed lentils	108	205	297
52	Stewed green grams	69	138	206
53	Stewed black beans	126	222	315
54	Stewed green peas	87	169	259
55	Roasted groundnuts	34	70	
56	Round sesame	48	72	140
57	Squared sesame	100	200	300
Vegetables				
58	Kales / Sukuma Wiki	70	140	210
59	Mixed traditional vegetables	102	204	306
60	Mixed Vegetables (carrots, courgette, peas)	79	138	207
61	Stewed cabbage	59	117	176
62	Stir-fried broccoli, cauliflower and carrots	38	76	144
63	Courgette	79	107	276
64	Cucumber	24	309	464
65	Eggplant	42		
66	Garlic clove	4		
67	Fresh tomato	204		
68	Fresh tomato - diced	119		
69	Fresh tomato - stripped	68		
70	Fresh tomato - sliced	96		
71	Fresh whole carrot	115	141	235
72	Fresh carrot - sliced	79		
73	Fresh carrot - stripped	90		
74	Fresh carrot - diced	122		
Fruits				
75	Orange - South African	112	141	159
76	Orange - local	186		
77	Tangerine	96	124	177
78	Pawpaw - small	87	168	306
79	Pawpaw - big	115	228	313
80	Watermelon	150	324	486
81	Mango (without seeds and peels)	151	230	237
82	Peach	82	164	246
83	Sweet banana	54	77	130
84	Purple passionfruit	9		
85	Tree tomato	63	85	125
86	Granadilla (sweet passionfruit)	20	42	50
87	Apple	92	134	177
88	Thorn melon	94	156	
89	Pineapple	80	160	240
90	Avocado (small)	43	89	181
91	Avocado (big)	135	262	524
92	Freshly squeezed fruit juice	540		

93	Grapes	109	181	263
94	Strawberry	85	126	253
95	Dates	100		
96	Pear	154	308	462
97	Kiwi	45	93	138
98	Black grapes	74	132	190
Milk and dairy products				
99	Fresh milk/mala	125	250	
100	Yoghurt	50	450	450
101	Butter	10		
Meats, poultry and eggs				
102	Stewed liver	69	128	188
103	Stewed offal	50	100	150
104	Stewed gizzards	59	119	193
105	African sausage	58	116	233
106	Stewed beef/goat/ mutton	56	111	167
107	Stewed chicken	80	159	239
108	Stewed pork	90	170	249
109	Ham - slice	36	72	108
110	Minced meat	73	147	220
111	Fried egg	50	100	150
112	Scrambled egg	89	178	266
113	Boiled egg	21	35	56
Fish and seafood				
114	Fried Tilapia (small)	53	92	146
114	Fried Tilapia (big)	108	149	259
115	Fish fillet (Nile perch)	91	183	274
116	Omena	53	105	158
117	Fish balls	72		
Oils and fats				
118	Olive oil/corn/soybean oil			
119	Vegetable cooking fat			
Spreads				
120	Honey	8	19	32
121	Margarine	3	6	9
122	Jam	4	16	28
123	Peanut butter	7	16	34
Snacks				
124	Low sugar cookies (Marie)	24	36	73
125	Low sugar tea biscuits	33	49	99
126	High sugar cookies and biscuits (Nuvita)	24	36	72
127	High sugar cookies and biscuits (Nice)	32	48	97
128	Cookies	34	52	104
129	High fibre biscuits (digestive)	37	56	113
130	High fibre biscuits (ginger)	22	43	63
131	Creamy biscuits	49		
132	Cakes (black forest, lemon cake slices etc.)	49	61	150
133	Queen cake (rich queen cake)	57	114	171
134	Queen cake (small)	52	106	239
135	Muffin	74	148	222

136	Chocolate ball	131		
137	Ice cream	50	60	100
138	Pop corn	25	50	100
139	Crisps	30	75	150
140	Wafer	78		
141	Amigos	100	200	300
142	Wow rings	250		
143	Sugar cane	311		
144	Sweets and candies	38	23	10
Beverages				
145	Carbonated cold drink	228	334	
146	Tea	83	166	321
Composite dishes				
147	Githeri	100	200	300
148	Mukimo	204	407	611
149	Pilau	81	162	243
150	Rice, carrots and potatoes	193	385	579
151	Toasted ham bread	73	109	146
152	Rice and beans	286	572	858
153	Kachumbari	41	82	124
154	Pizza (medium)	70	210	420
155	Pizza (large)	90	360	720
156	Pie	161	322	483
157	Hot dog	204	408	612
158	Hamburger (small, restaurant)	197	394	591
159	Hamburger (small, local shops)	202	404	606
Fried foods				
160	Chips - homecooked/supermarket	60	120	180
161	Chips - restaurant/chicken inn	191	382	573
162	Smokies	45	90	120
163	Hot dog sausages	49	98	147
164	Sausages	44	88	132
165	Choma sausage	74	148	222
166	Batter deep fried chicken e.g. KFC	99	138	207
167	Samosa (beef and vegetable)	29	51	62
168	Bhajia	126	257	383
169	Coloured deep-fried potatoes	102	195	363
170	Bacon	17	31	48
171	Kebab	155		
Spices and condiments				
172	Tomato sauce	20	40	60
173	Tomato sauce - Pizza Inn ketchup	10	20	

Appendix 13. Draft of instructions on how to use the photographic food atlas for quantitative food intake measurement - to be distributed with the second version of the atlas and included in possible further versions.

March 2020
KENFIN-EDURA

KENFIN - EDURA

Instructions

Using the photographic food atlas for quantitative food intake measurement

One of the most common ways of determining nutrition status is to quantitatively measuring food intake. To be able to reliably measure food intake, one must be able to accurately estimate food portion sizes. The Food Frequency Questionnaire (FFQ) and 24-hour recall interviews are two questionnaire types where the aim is to quantify retrospectively the amount of food a person has consumed.

This atlas has been developed to be used as an aid for 9-14-year-olds to aid in the filling of a FFQ or 24h recall. Below are detailed instructions on how to use the atlas with an FFQ and 24-hour recall. In both cases, we recommend that the questionnaires and atlas are administered to the participant aged 9-14 years by the interviewer.

FFQ

The aim of the FFQ is to determine a person's dietary intake over a longer period of time such as a week, month or year. FFQ data enables us to rank participants according to their dietary intake over a long period of time. In an FFQ, the food items of interested are listed and a participant must indicate the frequency of consumption per day, week or month.

As the food atlas is for the ages 9-14 years, it is recommended that the FFQ is interviewer-administered. The participant will also need help in navigating the photographic food atlas. It may be easiest to have two researchers: one who is the interviewer and one who aids the participant in the use of the atlas. The interviewer will ask the child whether they have consumed a food (going through the list of food items one by one). If the child says yes, the interviewer will then ask the child to indicate how many times per day or week (or month) in the past week (or month) they have consumed the food in question.

In a quantitative FFQ, a participant will also be asked to indicate their usual average portion size of the said food items during the past week (or month). At this point the other interviewer will be ready to show the participant the photograph series of the food in question and ask the participant to indicate which of the portion sizes represents their **usual average**

portion size. The interviewer will then report the portion size indicating the picture number and portion size letter to the other interviewer to record.

For most amorphous foods – foods that do not have any clear shape or size but are served in heaps or mounds – there are three portion sizes available. The participant can pick one of these portion sizes or a virtual portion size that is either smaller than portion A, between portion A and B, between portion B and C or bigger than portion C (Figure 1). In these cases, the portion sizes are determined as follows:

- less than A = 0.5 x A
- between A and B = 1.5 x A
- between B and C = 1.25 x B
- more than C = 1.5 x C

For foods that are served in clear units or pieces, such as fruits or breads, participants can be allowed to indicate fractions or multiplications of the portion sizes. However, it is important to remind the participant to keep thinking of their **usual average** portion size.

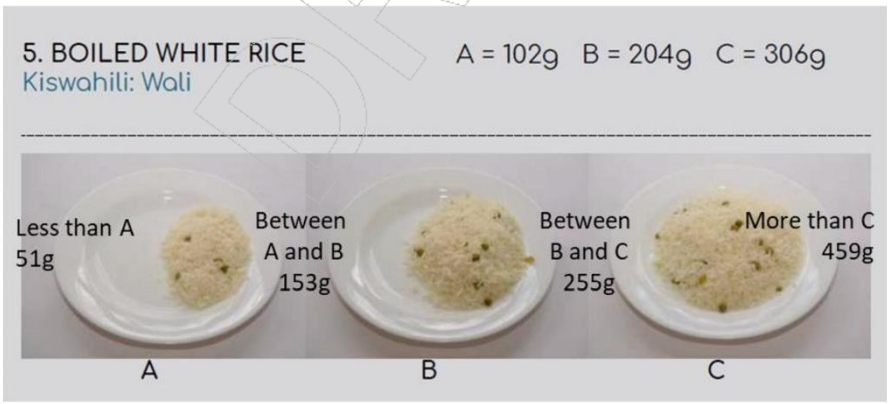

Figure 1. The photograph series of 3 portion sizes of boiled white rice with the virtual portion sizes indicated.

24-hour recall interview

In a 24h recall, the aim is to obtain information about the participants dietary intake during the previous day's 24 hours. 24h recall data gives us detailed information on individual dietary intake. In this case, it is important to obtain very detailed information on the portion sizes and recipes of what the participant has consumed.

First the researcher should go through what the participant did during the previous day to refresh their memory. Then the researcher will proceed with asking the participant about the foods they ate throughout the day starting from the moment they woke up to the moment they went to sleep. The participant will describe the foods they ate, and the researcher should ask the participant to describe their portion size. In some cases, the participant will be able to describe the size of the portion sizes accurately, for example, foods that are served in generally recognised unit sizes and packages such as yoghurts or biscuits.

If the participant consumes an amorphous food that is difficult to describe the shape and size of, the researcher should present the food in question in the photographic food atlas and ask the participants to describe their portion size as accurately as they can using the pictures in the atlas. They can describe the portion as being bigger, smaller or between the portion sizes in the atlas and the same calculation method can be used as described above (Figure 1). Note, that they do not have to stick to the portion sizes in the atlas; it is most important to get the most accurate estimate of the exact portion size they ate the previous day.

In the 24h recall it is important to ask clarifying questions about the foods eaten to get the most information about its quality and quantity. Hence, the interviewer should specify what types of, for example, meat (goat, beef, pork, chicken or other, which cut?), vegetables (Sukuma Wiki, spinach, managu, terere, saga, broccoli, tomato?), yoghurts (high or low fat, high or low sugar?), juices (sweetener or sugar, fresh pressed or concentrate?) or biscuits (high fibre, high sugar?) were consumed. Often, recipes are recorded including what type of flour (maize, millet, sorghum, wheat, full grain?) and oil (sunflower, olive?) were used. The researcher should always clarify if portion sizes were finished or if there were any leftovers. It is also a good idea to check if the person has had any snacks or foods in between meals as they can often be forgotten.

Missing foods

In the case that some foods, that the participant has consumed, are missing, the interviewer can use the photographic series of another food as a substitute. It is important that the food is of similar characteristics in density and volume.

Below is a list of some of the foods that may not have portion sizes represented in the atlas and which photographic series it is recommended to use instead. These suggestions have been made on the basis that these foods are similar (or relatively similar) in appearance, density and volume and they have similar average weights as based on the average portion sizes

from the United States Department of Agriculture and the National Food Composition Database in Finland (because there are no determined average intake portion sizes for Kenya).

- any beverages – picture 0. (Utensils on page 6)
- dried peas (e.g. cow, pigeon) – picture 53. (black beans) or 54. (green peas)
- French beans – picture 61. (stir-fried broccoli, cauliflower and carrots)
- onion – picture 61. (cabbage)
- mushrooms – picture 62. (stir-fried broccoli, cauliflower and carrots)
- cauliflower – picture 62. (stir-fried broccoli, cauliflower and carrots)
- broccoli – picture 62. (stir-fried broccoli, cauliflower and carrots)
- salad vegetables (lettuce) – picture 61. (cabbage)
- banana (large) – picture 44. (boiled plantain) or 83. (sweet banana)
- guava – picture 87. (apple)
- loquats – picture 95. (dates)
- plums – picture 95. (dates)
- wild berries – picture 94. (strawberries)
- cheese – picture 109. (ham slice)
- other birds (turkey, duck) – picture 107. (chicken)
- insects (grasshoppers, termites) – picture 116. (silver cyprinid fish)
- nyama choma/grilled meat – picture 106. (stewed beef/goat) or 108. (stewed pork)
- Nile perch and other types of fish – picture 115. (fish fillet)
- butter – picture 121. (margarine)
- biryani – picture 149. (pilau)
- chips and fries – picture 168. (bhajia) or 169. (coloured potatoes)
- sugar – picture 0. (Utensils on page 6)
- salt – picture 0. (Utensils on page 6)